Collection of Documents Describing MTU Diesel Military Engines series 830, 870 and 880

Compiled by Tank and AFV blog
http://tanksandafv.blogspot.com/

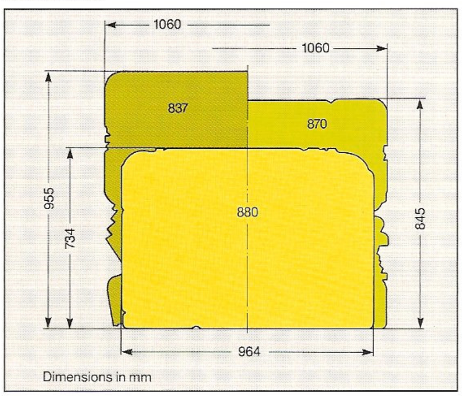
MTU
For Armoured Vehicles

mtu
Deutsche Aerospace

Introduction

MTU Friedrichshafen can draw upon more than 50 years of experience in armoured vehicle propulsion. Whereas MAYBACH developed and mass-produced gasoline engines, the breakthrough for tank diesels occurred in the fifties when DAIMLER-BENZ introduced its compact diesel engines for heavy military vehicles. With the merger of MAYBACH and DAIMLER-BENZ in 1965 and, finally, the creation of MTU in 1969, the responsibility for development, production, marketing and after sales support of those engines for tracked armoured vehicles was transferred to MTU Friedrichshafen.
Some 19,000 engines have since been produced and delivered for service in the armed forces of 20 nations.

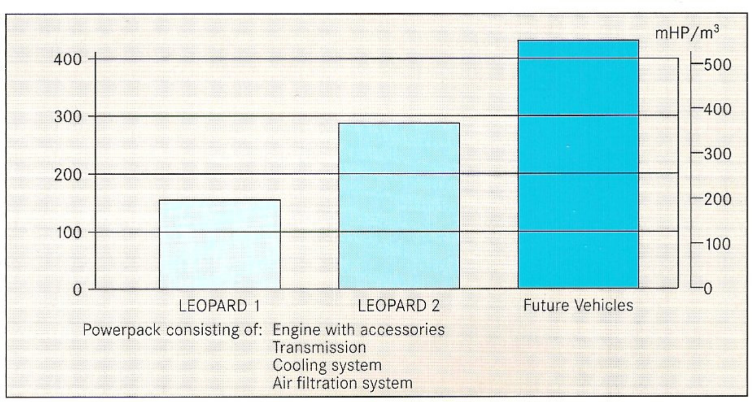
Comparison Series 837–870–880



MTU Powerpacks Integrated Propulsion Systems

The inherent advantages of MTU diesel propulsion systems result from the integration of all the component and subsystem functions during the conception, definition and development phases into a so-called Powerpack.
The engine, transmission, and all essential peripherals such as the air filtration system, cooling system, preheating device and electronic monitoring and control system, are considered as a unit – the optimal performance of the entire propulsion system being the major concern. This objective can only be fulfilled by complementing the advances in diesel engine technology with adequate technical progress made at the subsystem level.
The performances achieved by the engine series 837 and 870, and the operational characteristics of the third generation series 880 Powerpacks, are vivid testimony of the technological success in this respect.
The advantages of such Powerpack design meanwhile have been well recognized worldwide, and are increasingly adopted for modern tank concepts and re-powering programmes of existing vehicle fleets.

Installation Volume of Three Powerpack Generations



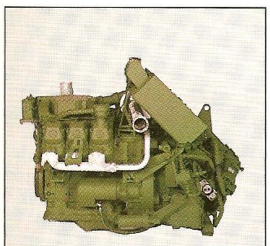
MTU Engine Programme for Military Vehicles

The large variety of vehicle design concepts, and the demand for propulsion system optimization, determine MTU's development and production programme.
The engine series 183, 837 and 870, rated from 220 kW up to 1325 kW (300 – 1800 mHP, offer a broad power spectrum.

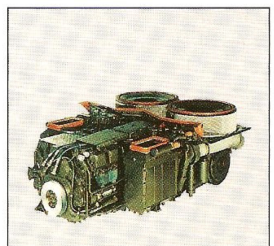
The intimate know-how gained in MTU's research laboratories, and the vast experience from the use of many thousands of these engines in military vehicle applications, have been invested in the 880 engine series – MTU's proposal for future vehicle generations.

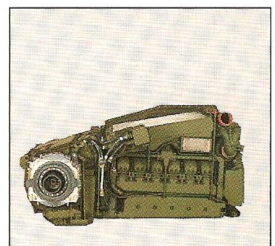
Design features of MTU diesel engines for armoured vehicles:

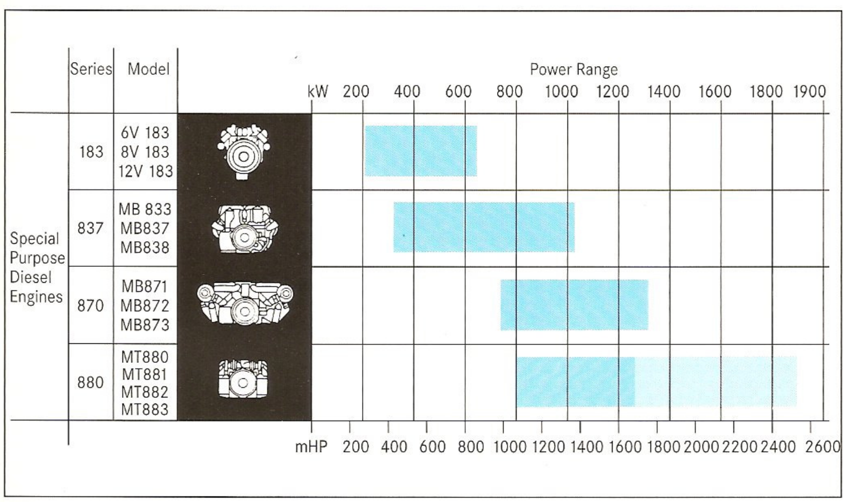
- ☐ 4-stroke cycle
- ☐ 90-degree Vee configuration
- ☐ Liquid-cooled
- ☐ High performance turbochargers (MTU development)
- ☐ Charge-air intercooling
- ☐ Dry sump, forced feed lubrication
- ☐ Individual cylinder heads
- ☐ Materials commonality


6V 183


MB 837


MB 873


MB 883



Engine Programme

MTU Engines and Powerpacks for Repowering Programmes

Combat-effectiveness improvement programmes for existing tank fleets extend the vehicle's operational life and thus contribute to reducing the lifecycle costs.
Replacing an obsolete gasoline engine with a proven tank diesel engine, called "dieselization", offers the following field-proven advantages:

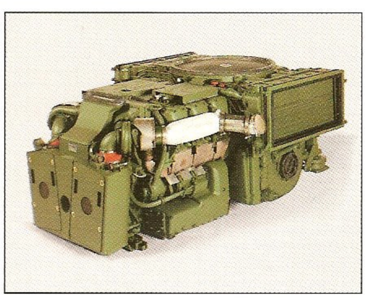
- ☐ Performance improvement
- ☐ Increased operational reliability, availability and durability
- ☐ Enhanced operational economy
- ☐ Simplified logistics

Renowned examples of such dieselization are M-47 and M-48/A1/A2 MBTs, which have been repowered with MB 837 diesels, keeping the installed Allison CD 850 transmission.

Other conversion programmes encompass vehicles initially equipped with a diesel unit. MTU's repowering kit for the AMX-30 battle tank serves as an example. The conversion involves only a minimum of engineering modifications to enable the installation of an MTU Powerpack, consisting of an 850 mHP MB 833 tank diesel engine, and a modern ZF LSG 3000 powershift transmission.
Such modernization programmes are particularly attractive for users which already employ MTU engines, because they take full advantage of simplified logistics and operator training as a result of engine-pool standardization.

MBT AMX-30

MB 833



MBT M 48

MTU Propulsion Kits for Tank Modernization

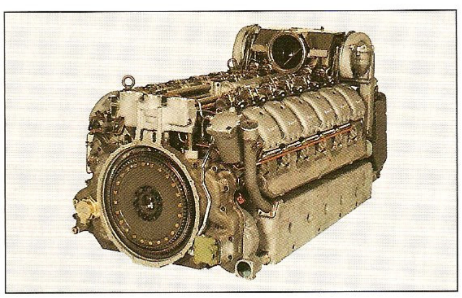
Tank Model	Type	Propulsion Power
M 113	Armoured Personnel Carrier	300 mHP
BMP	Armoured Personnel Carrier	300 mHP
AIFV	Armoured Inf. Fighting Vehicle	300 mHP
AMX 10	Light Tank	400 mHP
M 41/M 42	Light Tank/Anti-Aircraft Gun	450 mHP
M 44, M 52	Self-Propelled Gun	450 mHP
M 47	Main Battle Tank	750 mHP
M 48, 48 A1, 48 A2	Main Battle Tank	750 mHP
Super M 48	Main Battle Tank	1000 mHP
M 88	Recovery Vehicle	750 mHP
Centurion	Main Battle Tank	750 mHP
Vickers MK I/II/III, Vijayanta	Main Battle Tank	750 mHP
T 54, T 55, T 59, T 62	Main Battle Tank	750 mHP
AMX 30	Main Battle Tank	850 mHP
Leopard I	Main Battle Tank	950 mHP
M 60	Main Battle Tank	750/1000 mHP
OF 40	Main Battle Tank	1000 mHP
Chieftain	Main Battle Tank	1100 mHP

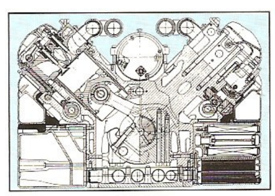
MTU –
a Cooperating Partner

The development and production of complex, sophisticated defense systems constitute a financial hardship for most countries. MTU's traditional and well-proven cooperation with powerpack component manufacturers at the domestic level has been supplemented for years by international cooperation with engine manufacturers. Joint ventures with partners in Italy, The Netherlands, Spain, Turkey, USA, the Republic of Korea and Switzerland have proved successful, and future commitments may include agreements with France, Great Britain, India and other partners.
As in the field of aero-engines, cooperation in the diesel engine field will no longer be restricted to license agreements. It has to include joint development and marketing tasks, as well as joint product support services.

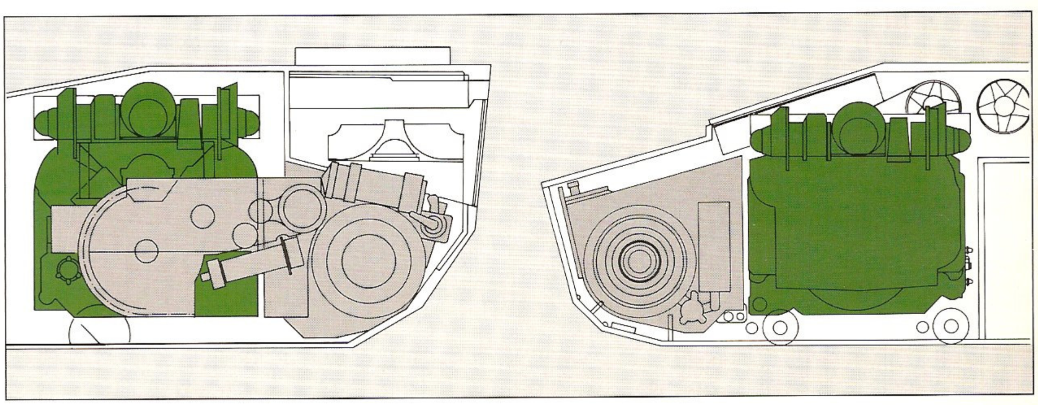
This kind of cooperation leads to the best results as the specific know-how and capabilities of each company would be used for the product, and thus for the benefit of the customer. Besides the requested commonality in army equipment, such collaboration would improve the economical situation regarding all phases of a vehicle programme, and allow for considerable reduction of life-cycle-costs.
Five NATO member states are currently independently engaged in the development and production of new armoured vehicles and main components, including the propulsion unit. To serve the forces with economical but highly effective and logistically optimized systems, international cooperation is an absolute must!
MTU introduced the conception of a common propulsion system for these new and future vehicles, and is prepared to share all tasks with interested partners within NATO – or comparable countries.

MT 883
Basic engine





Cross section
MT 883

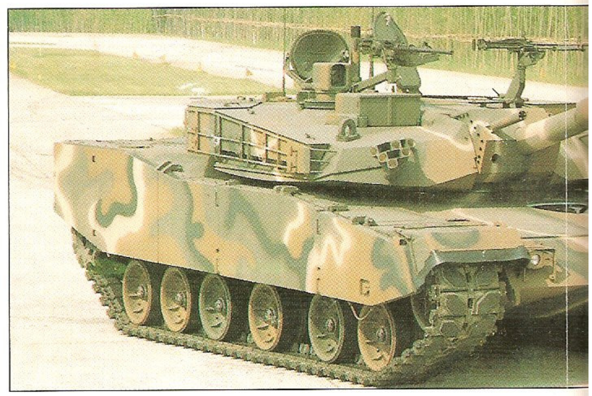


MT 883 transverse mounted (rear drive)

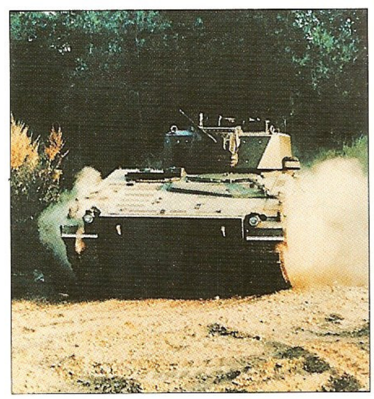
MT 881 transverse mounted (front drive)

Application Examples

Panzerhaubitze 2000

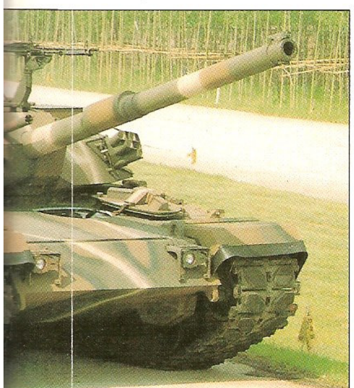


Marder 2



M 113

M 44



K-1

Büffel

44

Leopard 2

Keiler

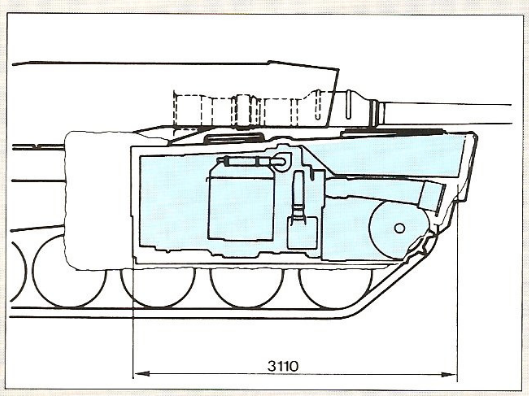
Powerpacks with MTU Series 880 Engines

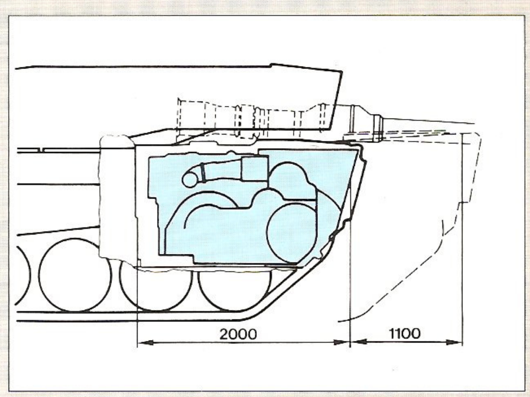
Future Prospects

The enormous development potential in the 880 high-performance diesel engine series becomes evident when comparing the Powerpack installation data of a modern tank, – the LEOPARD 2 – with an MT 883 transverse mounted Powerpack. The 880 Powerpacks – rear or front drive configuration – will very capably compete also with the gas turbine systems under contemplation for heavy tracked vehicles. In evaluating alternative power solutions, consideration should be given not only to the motive power, but also such essential aspects as development and procurement costs, development risks, operational economy, reliability and logistic support. MTU is firmly convinced that the tank diesel engine will continue to occupy a prominent position in future generations of armoured vehicles.

Decisive factors, among others, are the favourable power-to-procurement cost relationship and the modular design concept, which allow the engine family to cover a wide range of vehicles with different power requirements, while retaining virtually standardized logistics.

Installation Comparison
Powerpack with MB 873 and MT 883





Leopard 2 with MB 873 Powerpack

Length:	approx. 3100 mm
Volume:	approx. 7.06 m^3
Weight:	approx. 6.05 t
Vehicle volume:	38.8 m^3
Vehicle weight:	55.15 t

Powerpack with MT 883

Length:	approx. 2000 mm
Volume:	approx. 4.53 m^3
Weight:	approx. 5.18 t

Savings compared with Leopard 2

Vehicle volume:	5.15 m^3
Vehicle weight:	3.5 t

MTU Motoren- und Turbinen-Union Friedrichshafen GmbH
Dept. VFM · P. O. Box 2040 · 7990 Friedrichshafen / Germany
Phone (07541) 90-2450 · Telex 734280-0 mt d · Fax (07541) 903922

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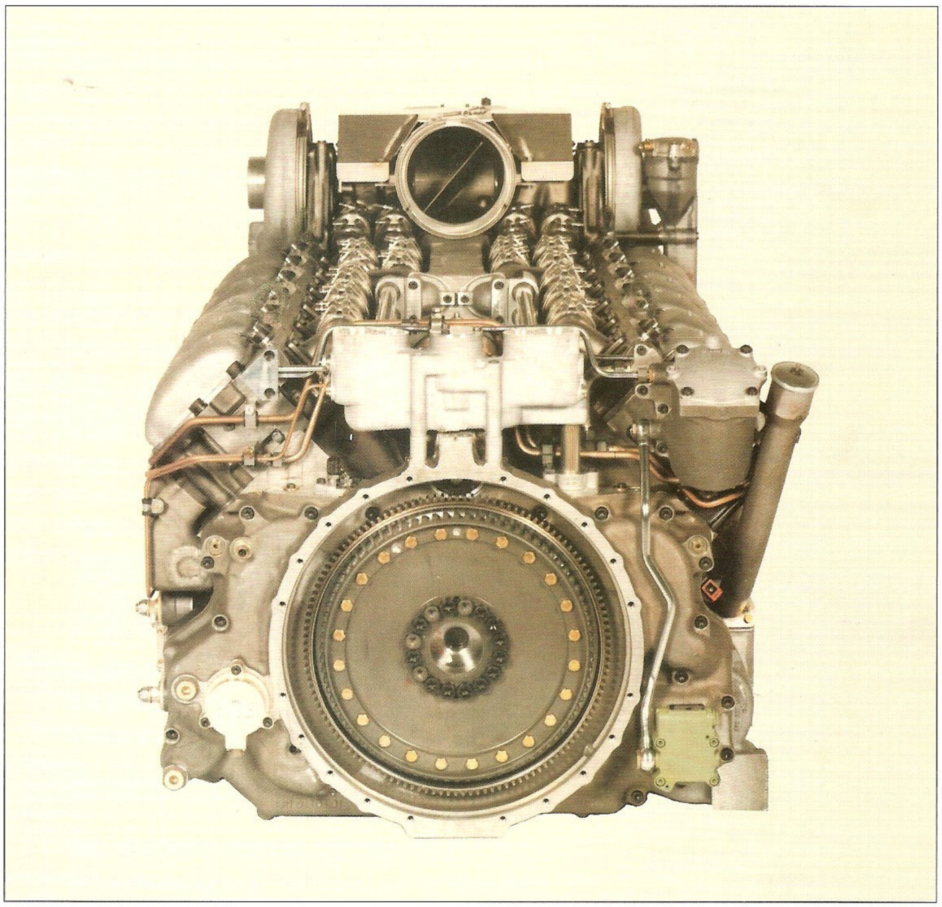
Series 880
Diesel Engines



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MTU Diesel Engines for Armored Vehicles

MTU Friedrichshafen and its predecessor companies, MAYBACH and MERCEDES-BENZ, have been involved in the design, development, manufacture and product support of propulsion systems for armored vehicles for more than 50 years.

This means that from the origins of modern tank forces MTU has been, and still is, instrumental in the design of power packs for various military vehicles and that the company has accumulated a great deal of experience in this particular field of application for high-performance engines.

The continuous demand for improvement of essential vehicle characteristics, e.g.

☐ Firepower
☐ Mobility
☐ Protection
☐ Safety
☐ Silhouette
☐ Economy

has resulted in stringent requirements regarding, for instance,

☐ Weight
☐ Engine power
☐ Power pack volume
☐ Fuel consumption
☐ Reliability
☐ Maintainability
☐ Durability
☐ Operational availability

These requirements have had a significant influence on engine and power pack concepts and have led to the tank diesel engine series offered by MTU today. The range of outstanding technical features described in this brochure has established MTU tank engines as the most suitable power units not only for newly developed combat vehicles, but also for combat effectiveness improvement programs involving the repowering of existing fleets.

Series 880

Since the mid-seventies, MTU has been working on the third-generation tank engine, the Series 880. With these engines the installation volume has again been considerably reduced so that, in future, engines with extremely small external dimensions and low weight will be available to cover the 750 mHP (550 kW) to 1630 mHP (1200 kW) power range. For instance, the 12-cylinder MT 883 engine has the same power rating as the Leopard 2 engine, but requires only 60% of its installation volume.

Major engine features: Direct fuel injection, 4 valves per cylinder, digital electronic engine management, variable turbocharger and intercooler arrangement for specific needs.

Modern turbocharger technology allows a high torque rise of 30% in the important speed range.

Prototype power packs have been built for several German and American vehicles, such as the German Howitzer 2000, the German AIFV Marder 2 as well as the American AAAV program (Advanced Assault Amphibious Vehicle).

Development of the second-generation tank engine, the Series 870, started in the mid-sixties. With reduced external dimensions and higher cylinder power ratings it has a considerably higher power density than the first generation engine, the MB 837. The 12-cylinder MB 873 engine, with 1500 mHP (1100 kW) for the Leopard 2 MBT and ARV and the 8-cylinder MB 871 with 1200 mHP (880 kW), are currently in series production at MTU and their licensees.

Engine Basic Data

Engine Model		MT 881 Ka-501	MT 883 Ka-501	MT 883 Ka-523*
No. of cylinders		8	12	
Power		800 kW (1100 mHP)	1200 kW (1630 mHP)	1920 kW (2600 mHP)
Bore/stroke	mm	144/140		
Displacement, cylinder	liters	2.28		
Displacement, total	liters	18.2	27.4	
Compression ratio		14.0:1	14.0:1	13.5:1
Direction of rotation		counterclockwise		
Cooling method		sealed, liquid-coolant system		
Combustion method		four-stroke diesel, direct injection		
Supercharging		2 turbochargers		sequential turbocharging
Intercoolers		2		2-stage
Starting method		electric		
Cylinder heads and valves		individual cylinder heads with 2 inlet and 2 exhaust valves		
Pistons		forged light-metal pistons, forced-feed oil cooling by spray nozzles		

* design potential

Design Features

The small engine envelope has been reached by careful design without "exotic" materials or techniques. All engine sub-assemblies, for instance, have been arranged so that connecting lines for combustion air, exhaust gas, coolant and oil are kept extremely short.

Known and standardized materials and production techniques have been employed, ensuring simplified machining, assembly and maintenance. Further feature are:

- ☐ 90° V-shaped cylinder arrangement. This allows an optimal arrangement of all engine sub-assemblies within a cubic design configuration.
- ☐ Crankshaft with small counterweight radius, therefore short, flat connecting rods.
- ☐ Individual injection pumps located between the cylinder heads, driven directly from the camshaft.
- ☐ Valve actuation through three pushrods per cylinder. The location of the camshafts allows a low rocker-arm arrangement and low engine installation height.
- ☐ Dry-sump lubrication system with side-mounted oil tank for safe operation at high inclinations.
- ☐ Two exhaust turbochargers with intercoolers integrated into the engine cooling system. Possibility of optimized arrangement within the power pack contour.
- ☐ Exhaust manifolds arranged in the Vee, charge air manifolds mounted externally, resulting in considerably cooler engine sides.
- ☐ Oil pumps located in oil pan, two scavenge pumps and one pressure pump combined into a block-type assembly.
- ☐ Oil tank with filler neck mounted to crankcase side.
- ☐ Oil-to-coolant heat exchanger mounted to engine side, compact aluminum construction.
- ☐ Oil filters in main oil supply line use paper fine filter elements; additional safety filters.
- ☐ Three oil manifolds; main gallery provides for crankshaft lubrication and piston cooling; two hollow camshafts supply lube oil to valve gear and injection pumps.
- ☐ Electric starter located in the Vee.
- ☐ 22.4 kW alternator mounted within engine contour, driven by a hydrodynamic coupling and cooled with engine oil.

Component design optimization has been based on thoroughly proven parts.

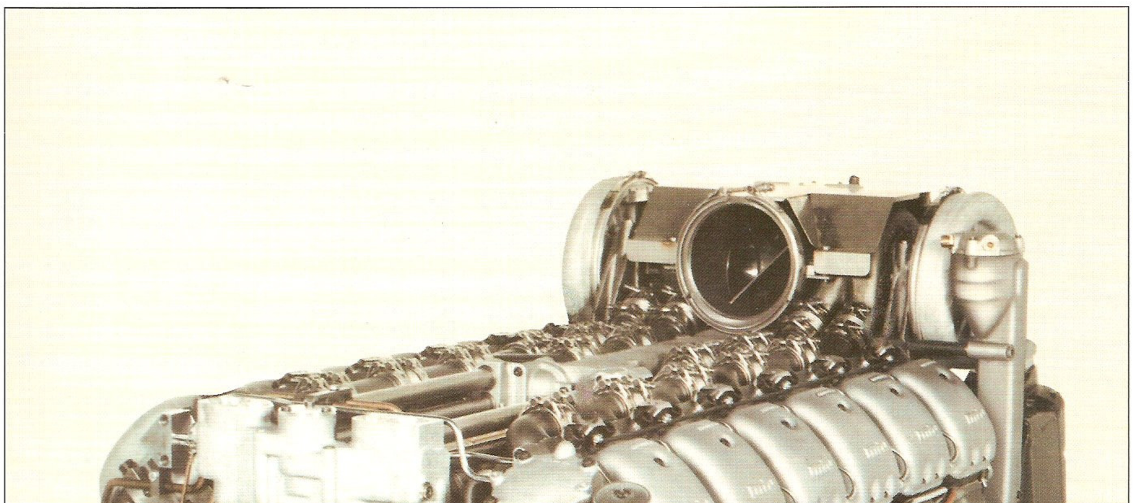
- ☐ Aluminum crankcase extending below crankshaft centerline; steel bearing caps; flat dry-sump oil pan.
- ☐ Gear train at flywheel end; gearcase separated from crankcase.
  Spur gears; anti-friction bearings.
  Drives for: camshafts, coolant pump, oil pumps and alternator.
- ☐ Induction-hardened crankshaft finished all over; full power can be tapped from either end.
- ☐ Simplified logistics through:
  - High degree of parts commonality
  - Reduced stock inventory
  - Use of standardized tools and equipment
  - Standardized test procedures
  - Identical training for maintenance and operator personnel.

Electronic Engine Control Module

Series 880 engines have a digital electronic control module which performs the following main functions:

- ☐ Fuel injection control to achieve optimum torque characteristics
- ☐ Prevention of smoke emissions during vehicle acceleration
- ☐ Engine power control as a function of radiator capacity in extreme ambient temperatures
- ☐ Radiator fan speed control to suit cooling requirements in normal ambient temperatures
- ☐ Automatic starting sequence
- ☐ Dust ejection blower control
- ☐ Monitoring of engine speed, oil pressure, coolant flow and coolant level

The electronic control module is a nuclear hardened unit with TREE and EMP protection.



MT 883 Ka-501

Application Examples

AAAV
MT 883 Ka-501
Technology
Demonstrator

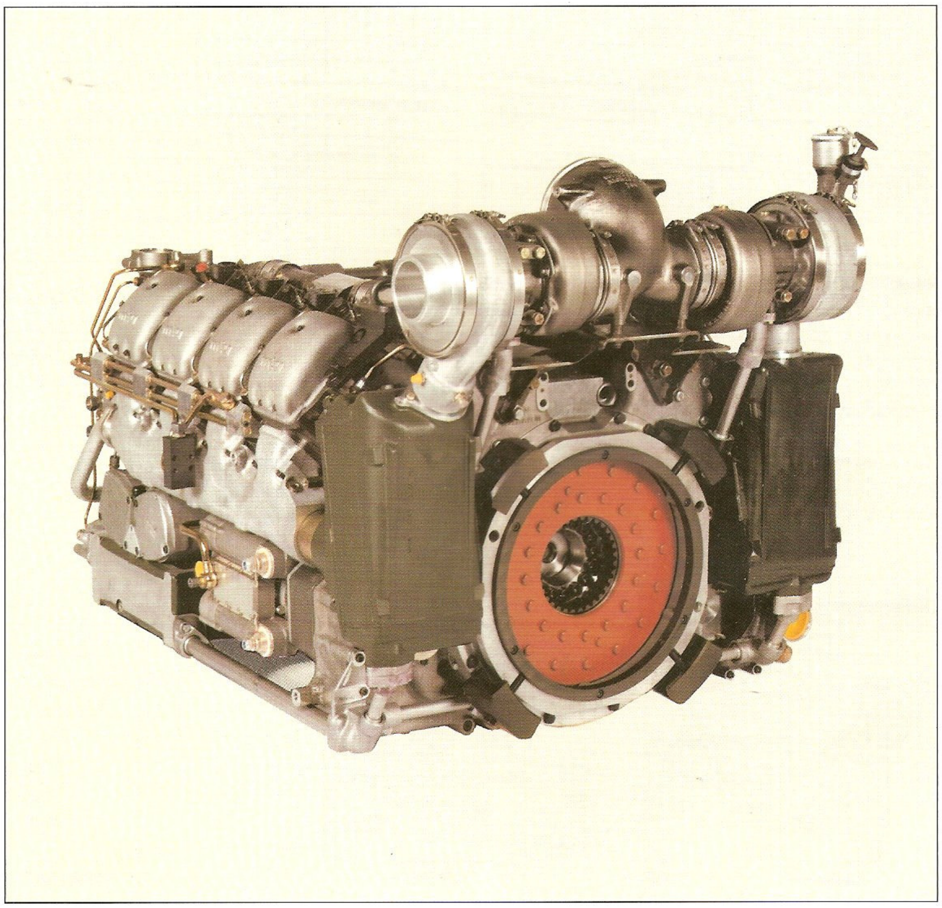
German Howitzer
PzH 2000
MT 881 Ka-501

German AIFV
Marder 2
MT 881 Ka-501

Eight-Cylinder Diesel Engines for Heavy Military Vehicles

MT 881

800 kW (1100 mHP) at 2700 or 3000 rpm



MT 881 Ka-501

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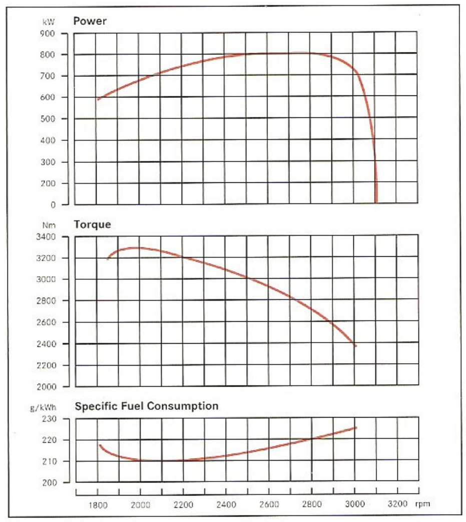
Diesel Engine MT 881

Engine version	MT 881 Ka-501, turbocharged (2 chargers)/intercooled
Bore/stroke	144/140 mm (5.7/5.5 in.)
Displacement, cylinder	2.28 liters (139 cu. in.)
Displacement, total	18.2 liters (1111 cu. in.)
Number of cylinders	8 cylinders, 90° Vee configuration
Compression ratio	14.0:1
Cooling method	pressurized, closed-circuit liquid cooling system
Injection method	direct injection
Starting method	electric
Cylinder heads	individual four-valve heads
Pistons	light-metal forgings, oil-cooled
Number of main bearings	5
Direction of rotation	counterclockwise



Power Ratings Definition
In accordance with ISO 1585 (fan power requirement to be deducted)

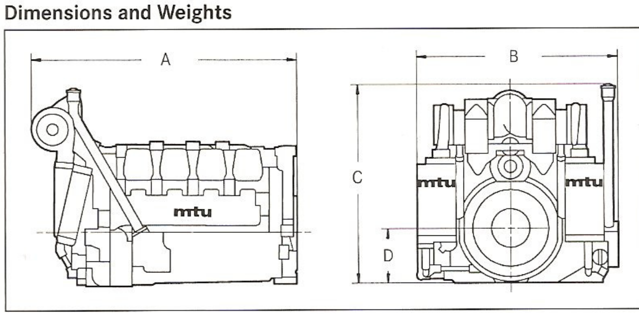
Inclinations pitch 35°
roll 35°
Any combination of the two inclinations must not exceed 35°, with roll being limited to max. 35°

Climatic Conditions
Engines can be operated under ambient temperature conditions of −46°C to +52°C in accordance with NATO standards.
At temperatures below −20°C, oil has to be preheated.

Fuels
Standard:
VV-F-800 DF-2/F-54,
VV-F-800 DF-1/F-56 (below −15°C)
Alternative:
MIL-T-83133B (F-34)

Lube Oils
MIL-L-2104C/D (O-238)
TL9150-063/3 (O-236)

Dimensions and Weights



A	1425 mm
B	964 mm
C	813 mm
D	283 mm
Weight approx.	1390 kg

Dry weight of basic engine configuration, incl. starter, generator and cabling.
Oil capacity approx. 70 kg. Coolant capacity approx. 100 kg.

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MTU Motoren- und Turbinen-Union Friedrichshafen GmbH
Dept. VFM · P.O. Box 2040 · D-7990 Friedrichshafen, Germany
Phone (0 75 41) 90-24 50 · Telex 7 34 280-0 mt d · Telefax (0 75 41) 90-39 22

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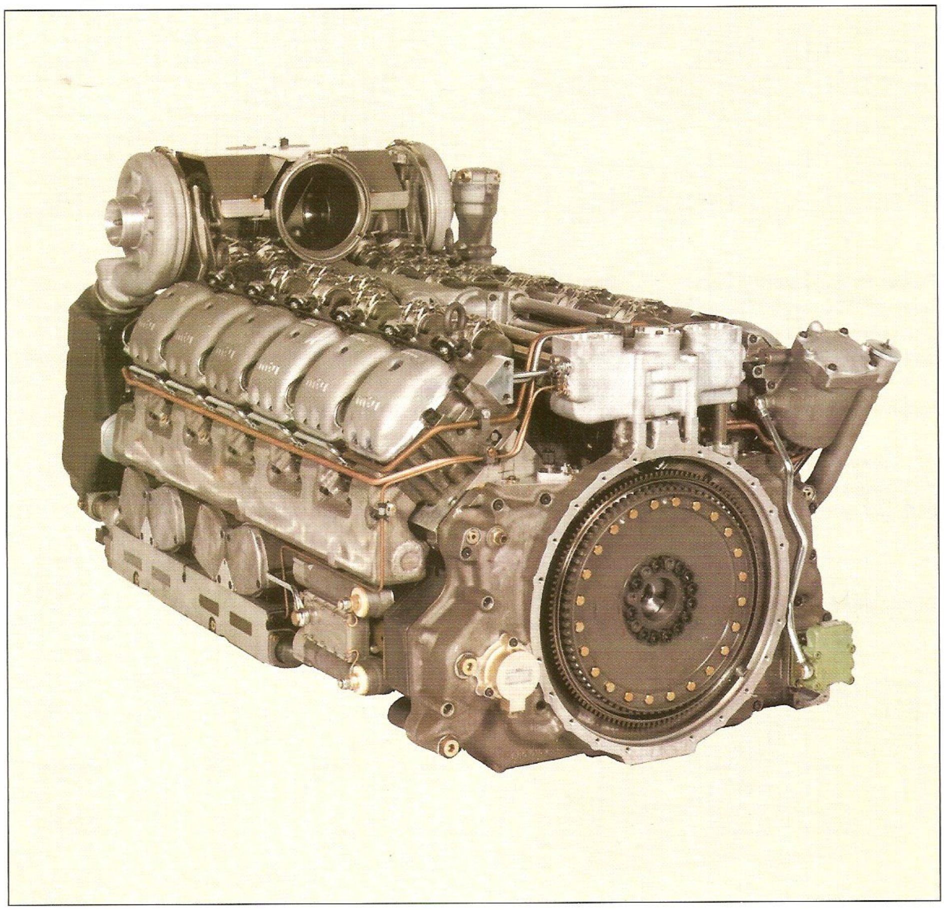
Twelve-Cylinder Diesel Engine for Heavy Military Vehicles

MT 883

1200 kW (1630 mHP)
at 2700 or 3000 rpm

Power Potential:
1920 kW (2600 mHP) at 3300 rpm



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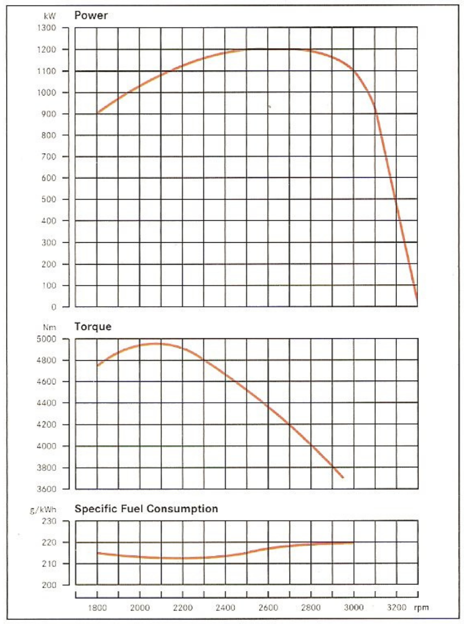
Engine version	MT 883 Ka-501, turbocharged (2 chargers)/intercooled
Bore/stroke	144/140 mm (5.7/5.5 in.)
Displacement, cylinder	2.28 liters (139 cu. in.)
Displacement, total	27.4 liters (1672 cu. in.)
Number of cylinders	12 cylinders, 90° Vee configuration
Compression ratio	14.0:1
Cooling method	pressurized, closed-circuit liquid cooling system
Injection method	direct injection
Starting method	electric
Cylinder heads	individual four-valve heads
Pistons	light-metal forgings, oil-cooled
Number of main bearings	7
Direction of rotation	counterclockwise



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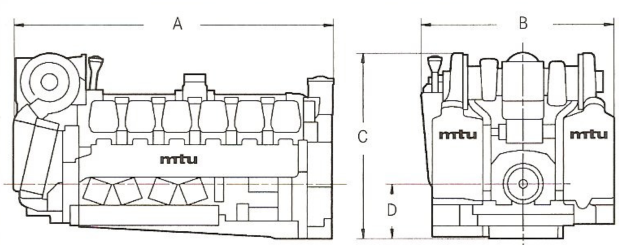
Dimensions and Weights



A	1700 mm
B	964 mm
C	965 mm
D	283 mm
Weight approx.	1780 kg

Dry weight of basic engine configuration, incl. starter, generator and cabling.
Oil capacity approx. 90 kg. Coolant capacity approx. 114 kg.

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MTU Motoren- und Turbinen-Union Friedrichshafen GmbH
Dept. VFM · P.O. Box 20 40 · D-7990 Friedrichshafen, Germany
Phone (0 75 41) 90-24 50 · Telex 7 34 280-0 mt d · Telefax (0 75 41) 90-39 22

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MTU Motoren- und Turbinen-Union Friedrichshafen GmbH
Dept. VFM · P.O. Box 2040 · D-7990 Friedrichshafen, Germany
Phone (07541) 90-2450 · Telex 734 280-0 mt d · Telefax (07541) 90-3922

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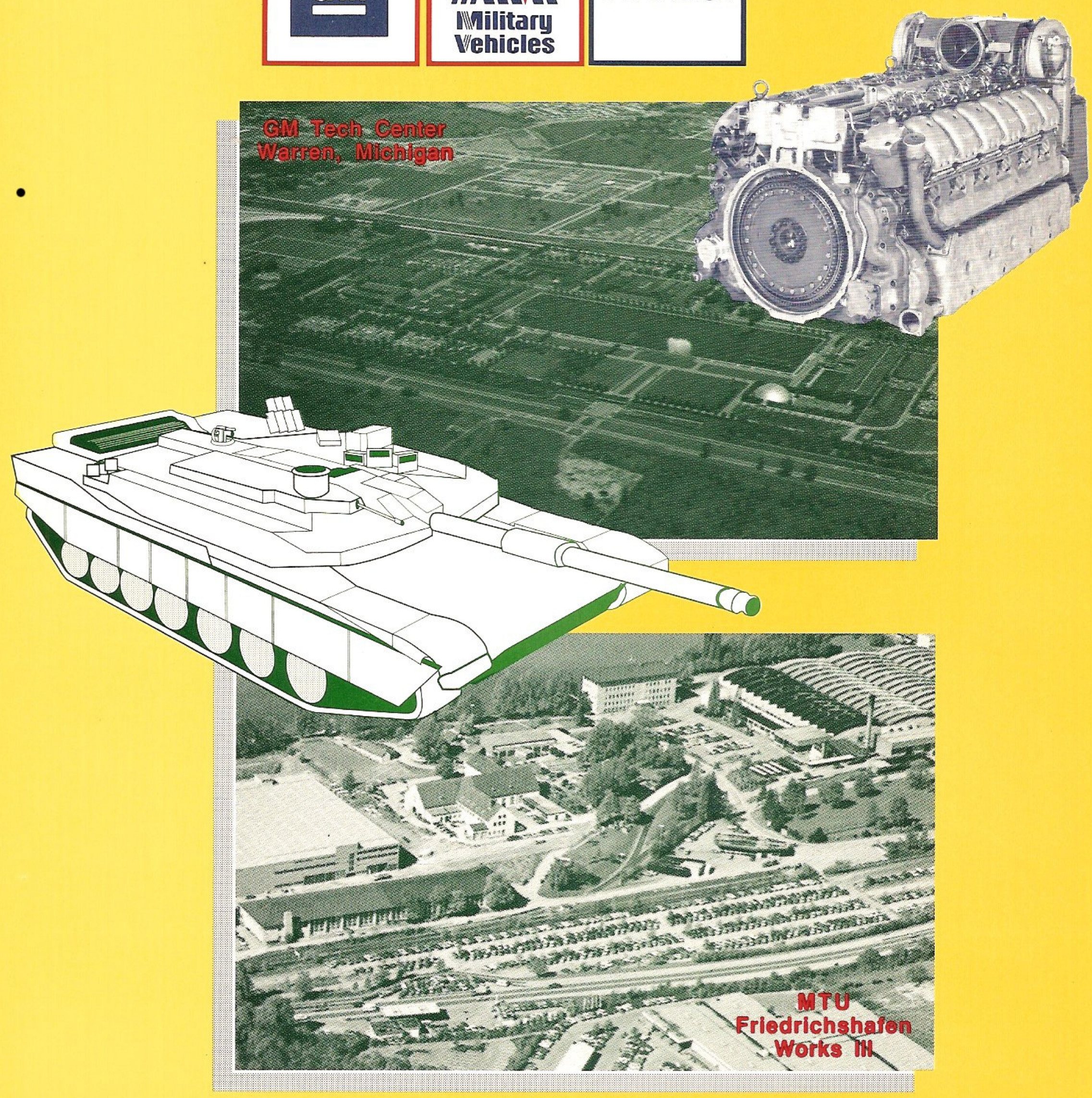
The MT 880 Engine Family

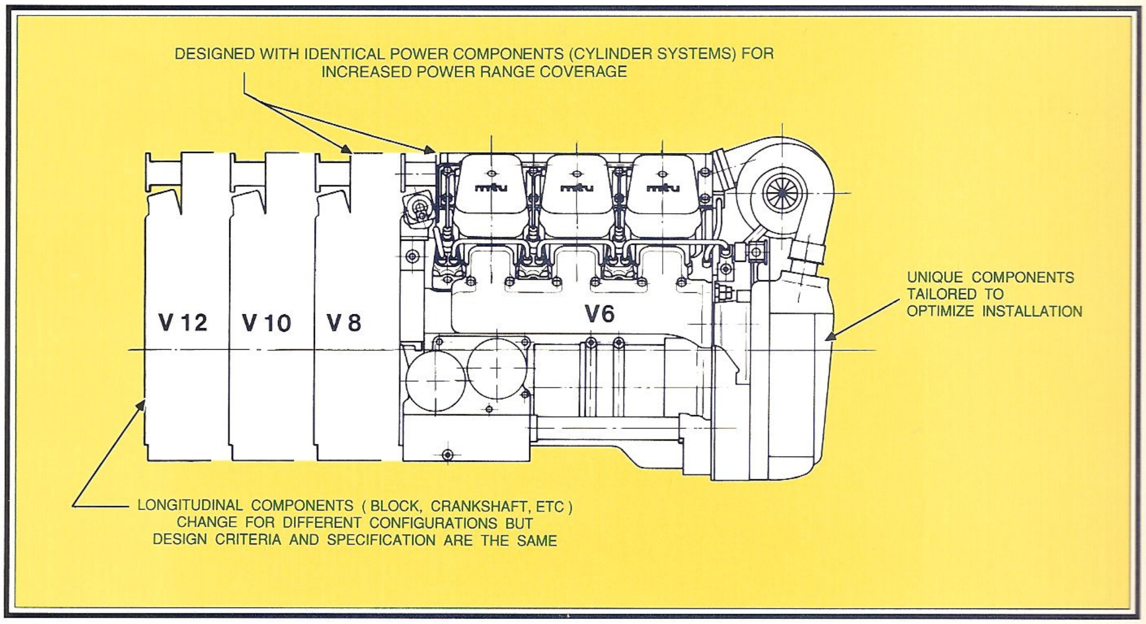


GM & MTU, TEAMED FOR THE FUTURE

Armored Vehicle Engine Family of the Future

SUMMARY - BASIC ENGINE
880 ENGINE FAMILY

- Covers an extended power range (750 HP to 1500 HP) with similar configurations of identical components
- Low development risk by using proven MB 837 and MB 870 design base in terms of
  - Mechanical load
  - Thermal loads
  - Materials
- High power concentration resulting in
  - Compact engines
  - Highly integrated power packs
- Advanced logistic concept
  - Family concept
  - Parts commonality
  - RAM-D characteristics



MT 880 TANK ENGINE FAMILY FEATURES

- 90° - V configuration
- Dry sump lubrication system
- Liquid cooled
- Integrated electric power generation
- Aluminum alloys
- No rubber parts

A Typical Application - Potential for M1 Block III

Power Pack Installation
M1A1 Hull - MT 883 Ka500 - XT 6775 Transmission

- State-of-the-art transmission technology
- Hydrokinetic, transverse, single centerline design
- 7 speed automatic range pack
- Hybrid friction plate / retarder braking system
- Integral fan and auxiliary automotive drives
- Optional 400 HP special payload PTO
- New digital electronic controls
- Continuously-variable, hydrostatically controlled differential steer with crescent steer capability

General Specifications

- Input rating 1100 kW @ 3000 rpm
- Range ratios & turning radius

•

	Ratio	Turning Radius (m)
First	8.323	2.8
Second	5.219	4.3
Third	3.727	6.6
Fourth	2.474	10.0
Fifth	2.023	12.1
Sixth	1.390	17.4
Seventh	0.944	22.6

Output rating

- Stall tractive effort 1.2*GVW
- Maximum continuous tractive effort 0.7*GVW

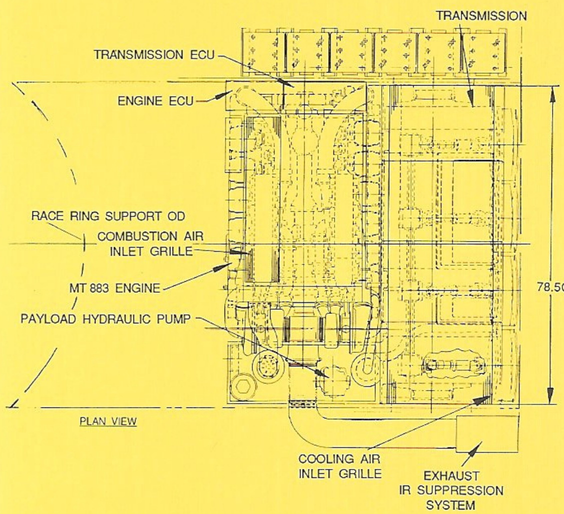
Braking capability

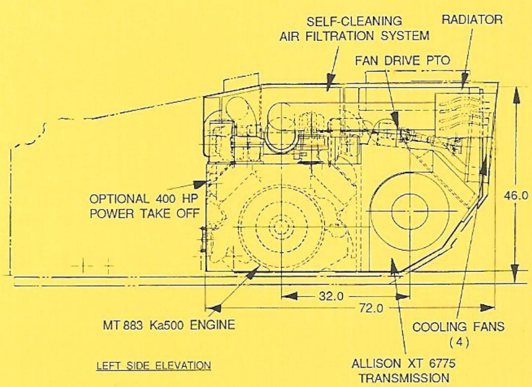
- Peak $7\ m/s^2$
- Average $5\ m/s^2$

Top Speed 75 kph
Weight (Transmission) 1905 kg

<u>VEHICLE PERFORMANCE</u>

- Meets the AFV sprocket power requirement with
  - Fans operating
  - 5 kW auxiliary power being generated
  - Ambient temperature at 30° C
  - Altitude of 150 m
- Meets AFV tractive effort requirements
  - Stall TE = 1.2*GVW
  - Cools at 0.7*GVW
- Has crescent steer capability, retarder type braking and autonomous functions required for medium weight vehicles of the future





Application For Medium Vehicles - Approx. 45 Tons

Power Pack Installation
Medium AFV Hull - MT 881 Ka500 - AX 4557
Transmission

- State-of-the-art transmission technology
- Hydrokinetic, transverse, single centerline design
- 7 speed automatic range pack
- Hybrid friction plate / retarder braking system
- Integral fan and auxiliary automotive drives
- New digital electronic controls
- Continuously-variable, hydrostatically controlled differential steer with crescent steer capability

General Specifications

- Input rating 750 kW @ 3000 rpm
- Range ratios

	Ratio
First	10.14
Second	6.40
Third	4.20
Fourth	2.77
Fifth	2.29
Sixth	1.72
Seventh	1.32

Output rating

- Stall tractive effort 1.2*GVW
- Maximum continuous tractive effort 0.7*GVW

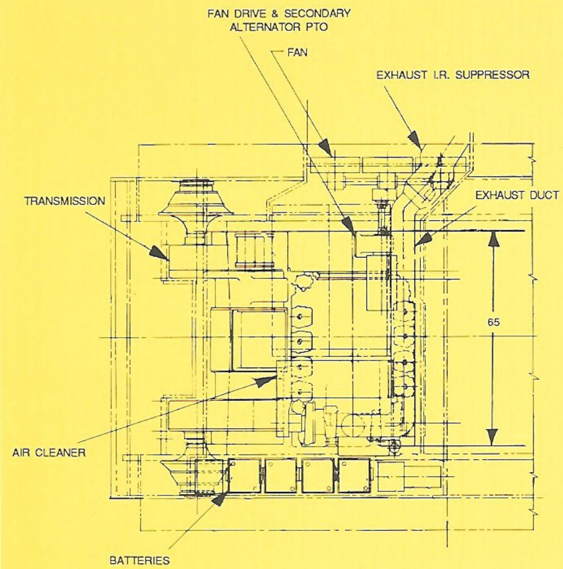
Braking capability

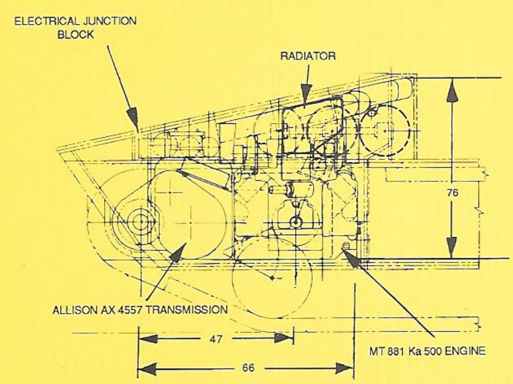
- Peak $7\ m/s^2$
- Average $5\ m/s^2$

Top Speed 75 kph
Weight (Transmission) 1770 kg

VEHICLE PERFORMANCE

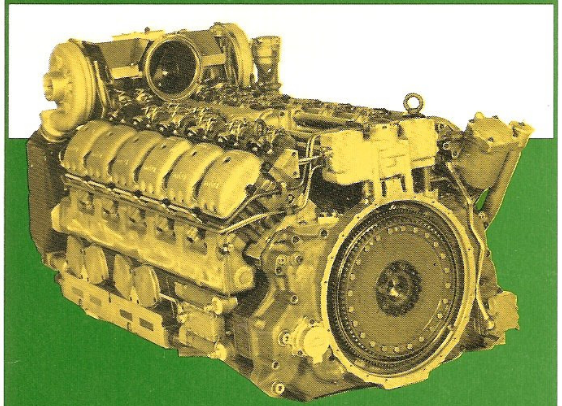
- Meets the AFV sprocket power requirement with
  - Fans operating
  - 5 kW auxiliary power being generated
  - Ambient temperature at 30° C
  - Altitude of 150 m
- Meets AFV tractive effort requirements
  - Stall TE = 1.2*GVW
  - Cools at 0.7*GVW
- Has crescent steer capability, retarder type braking and autonomous functions required for medium weight vehicles of the future
- Built in offsets provide desired output centerline while allowing frontal protection by future armors.





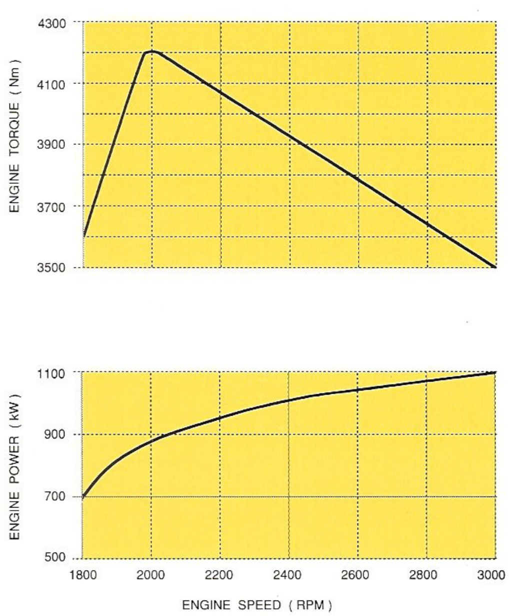
Features

12 CYLINDER MT 883 ENGINE

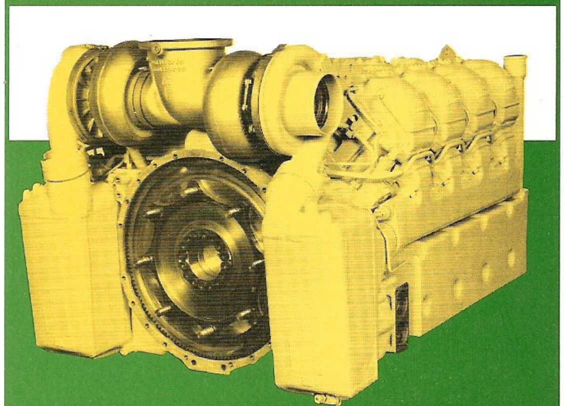


Model	MT 883 Ka 500
Rated Power	1100 kW
Rated Speed	3000 rpm
Maximum Torque	4201 Nm @ 2000 rpm
Governor Droop	3360 rpm
Bore	144 mm
Stroke	140 mm
Bmep	
at rated	16.1 bar
at maximum torque	18.1 bar
Displacement	27.36 liter
Length x Width x Height	1655 mm x 940 mm x 656 mm
Incline	
fore - aft	60 %
Side-to-side	40 %

MT 883 ENGINE PERFORMANCE:

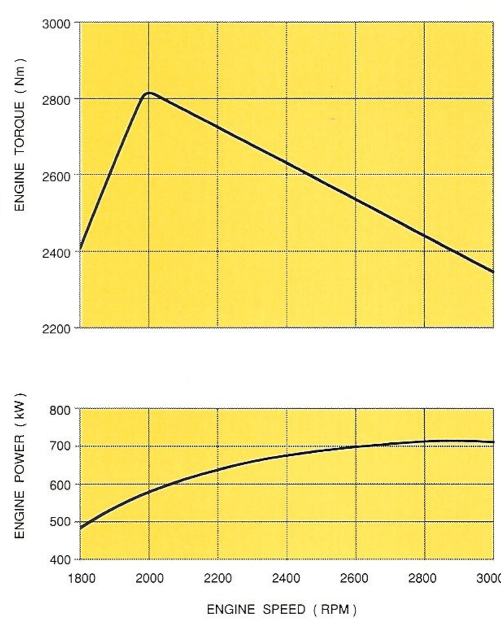


8 CYLINDER MT 881 ENGINE



Model	MT 881 Ka 500
Rated Power	736 kW
Rated Speed	3000 rpm
Maximum Torque	2811 Nm @ 2000 rpm
Governor Droop	3360 rpm
Bore	144 mm
Stroke	140 mm
Bmep	
at rated	16.1 bar
at maximum torque	18.1 bar
Displacement	18.24 liter
Length x Width x Height	1275 mm x 940 mm x 656 mm
Incline	
fore - aft	60 %
Side-to-side	40 %

MT 881 ENGINE PERFORMANCE:



Payoffs

HIGH RELIABILITY

- Design evolution from proven MB 837 to MB 870 series spanning over 30 years.
- Uses fully developed components
- Conservative design philosophy
  - -Stay within proven mechanical & thermal load limits
  - -Use proven materials
  - -Use proven machining/production techniques
- Reliability advantages of integrated system: engine, cooling, air filtration, transmission

LOGISTICS BENEFITS

- Engine to engine, cylinder to cylinder parts commonality
- Identical internal power components
- Identical injection lines
- Identical injection pumps
- Identical inlet & exhaust valves
- Exhaust system with identical parts
- No head gaskets
- Minimized external plumbing

HIGH PERFORMANCE

- Meets or exceeds AIPS requirements

LOWER LIFE CYCLE COST

- Lower acquisition costs
- Lower O & S costs

REDUCED FUEL CONSUMPTION

- 298 gallons per battlefield day vs. 500 + gallons per battlefield day for current M1A1
- Superior diesel specific fuel consumption
- Low idle fuel consumption

MT 880 ENGINE PRODUCTION AVAILABILITY

	Available
• MT 883 12 cylinder 1500 HP	1989
• MT 881 8 cylinder 1000 HP	1990

For information contact:

Military Vehicles Operation
General Motors Corporation

Address:
1911 N. Ft. Myer Drive, Suite 800
Arlington, VA. 22209-2193

Donald A. (Bo) Campbell

Phone: (703) 284-1741
Telefax: (703) 284-1759

Address:
7000 Chicago Rd.
Warren, Michigan 48090-9005

Roger B. Burrows

Phone: (313) 492-2128
Telefax: (313) 492-3192/2525

GM

Military Vehicles

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Series 880

Diesel Engines

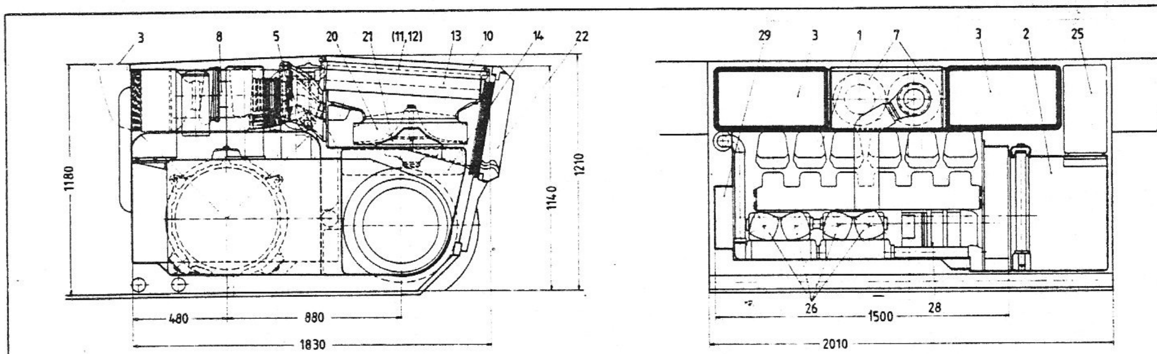
mtu

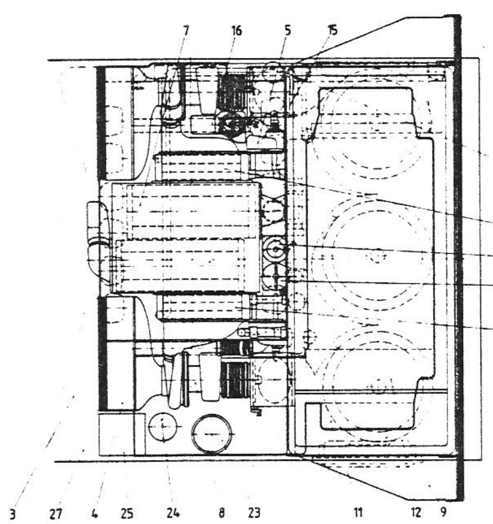
The Series 880 engines permit a large number of power pack concepts for a wide range of vehicle configurations. The small dimensions of the engine, in particular the low height, make new and extremely space-saving arrangements possible. Naturally, state-of-the-art cooling, air filtration and power shift transmission technologies are incorporated into these power pack concepts.

For instance, a rear-drive power pack with transverse 12-cylinder engine arrangement has been designed for the heavy vehicle power range. Compared to the Leopard 2 power pack, this arrangement would allow the length of the engine compartment to be reduced by more than 1 meter and the height to be reduced by 10 cm. For front-drive, medium-weight vehicle applications, such as the Marder APC, the space savings achieved can be used optionally to either reduce the front-end dimensions and/or to increase installed engine power.

The small dimensions and low weight of power packs with Series 880 engines permit new and better solutions to the controversial requirements for protection and mobility within given weight limits and, therefore, more scope for optimization.

Power Pack for MBT with MT 883 Diesel Engine





1 MTU 12-cylinder MT 883 Ka 500 diesel engine
2 Renk transmission
3 Combustion air inlet
4 Prefilter (double-cyclone)
5 Coarse dust extractor fan
6 Intercooler
7 Fine filter
8 Turbocharger
9 Exhaust outlet
10 Cooling air inlet
11 Fuel heat exchanger
12 Flat-type cooler, charge air circuit
13 Flat-type cooler, main circuit
14 Transmission oil heat exchanger
15 Coolant-to-coolant heat exchanger
16 Coolant expansion tank, preheating circuit, with filler neck
17 Coolant expansion tank, main circuit, with filler neck
18 Main coolant thermostat
19 Oil filler neck
20 Cooling fans
21 Hydrodynamic coupling
22 Cooling air outlet
23 Transmission oil filter
24 Fuel filter
25 EMU (Engine Monitoring Unit)
26 Engine oil filter
27 Space for engine connections
28 Generator
29 Vibration damper

Subject to modifications in the interest of technical progress.

mtu

Motoren- und Turbinen-Union Friedrichshafen GmbH
P.O. Box 2040 · D-7990 Friedrichshafen/W.-Germany
Phone (07541) 29-1 · Telex 734280-0 mt d · Telefax (07541) 292247

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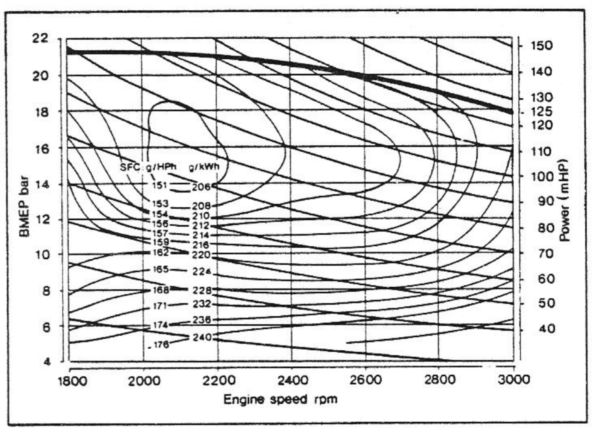
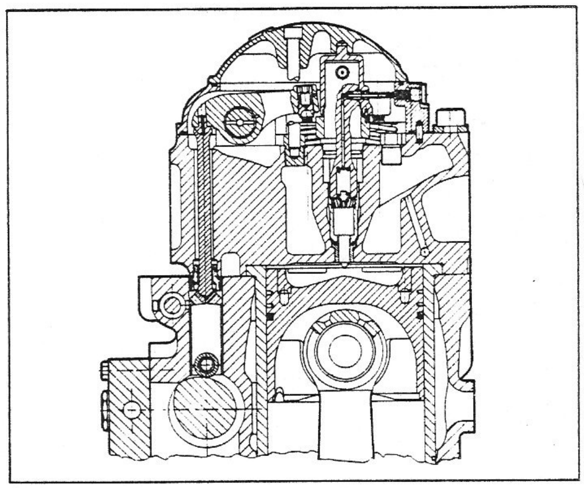
As an alternative to the currently used pre-chamber combustion system, research is being carried out on a single-cylinder engine to determine the advantages offered for tank engines, with their special requirements, by direct fuel injection. Reduced fuel consumption (162 g/HPh at rated power) and heat dissipation to the engine coolant must be weighed against the well-known good cold start characteristics of the pre-chamber engine and its capability of handling prolonged periods of idling and low-load operation in field service. Both combustion systems employ the same connections and can be optionally realized within the engine concept.

Performance Map, Single-Cylinder Research Engine (Direct Injection)



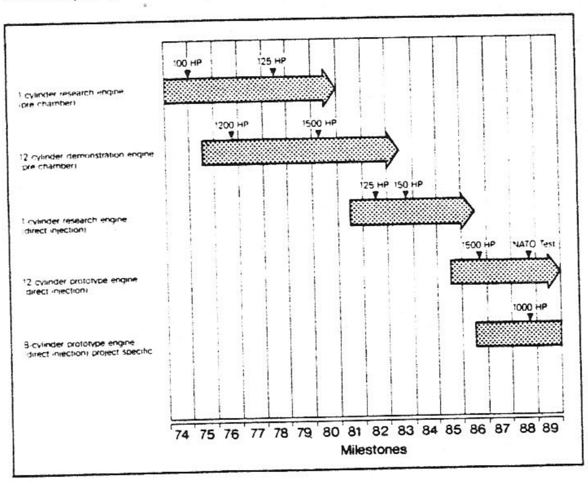
Cylinder Head (Direct Injection)



Based on the good results achieved with the electronic elements of the engine control system used on the MB 873 engine for the Leopard 2 battle tank, the advantages of electronic governing and control systems have also been employed on the Series 880 engines. The electronic governor used has been developed by MTU and incorporates microprocessor technology. In addition to idling and maximum speed control, which is standard for vehicular applications, this governor allows full utilization of the permissible power range without risk of the limit values for safe engine operation being exceeded. Engine governing and monitoring have thus been closely allied to each other. Redundancy ensures the required degree of reliability. An injection timer, currently under development, will also be controlled electronically as a function of engine load and speed.

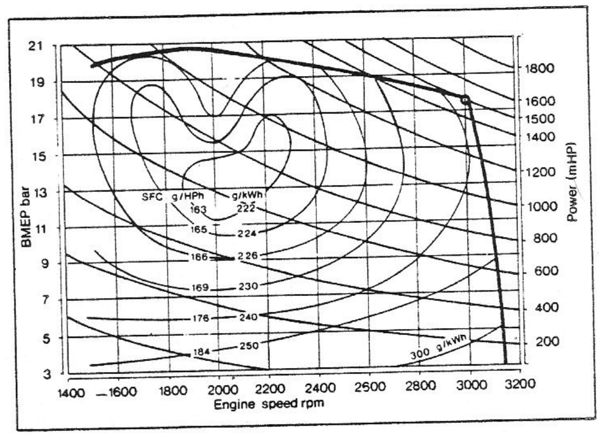
The design basis for the complete engine series, covering all of the various cylinder counts, has been defined and the production documentation is available for 12-cylinder pre-production engines. Combustion research was first carried out with a single-cylinder unit and the well-tried pre-chamber injection system was optimized. As the single-cylinder engine incorporates a large number of parts identical to those used in the multi-cylinder version, e.g. piston, connecting rod, cylinder liner, cylinder head, valve gear, fuel injection equipment, etc. the functional capability of the engine concept could soon be confirmed with a 12-cylinder prototype. Neither the combustion process, at speeds of up to 3300 rpm, nor the various sub-assemblies produced any evidence of concept-specific limitations.

Development History



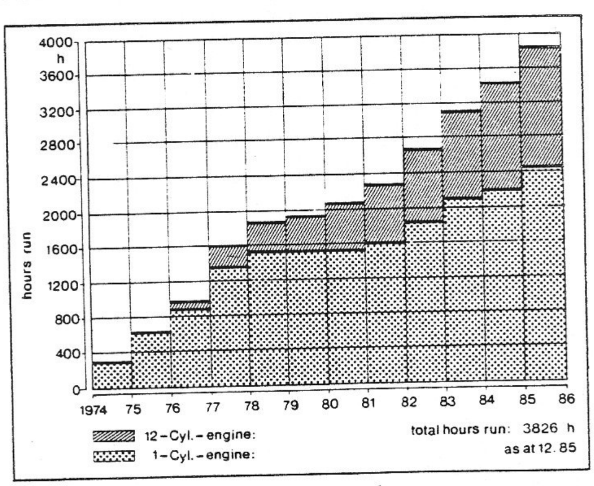
In the meantime test runs with several 12-cylinder engines have confirmed the complete usability of this new engine concept. For instance, the specified target power rating of 1500 mHP at 3000 rpm, was achieved with good operational values and without difficulty. Without special optimization measures, the specific fuel consumption was 177 g/HPh at rated power and 160 g/HPh at the optimum point which are excellent values for a pre-chamber diesel engine operating at such high speeds.

Performance Map, 12-Cyl. MT 883 Ka 500 (Prechamber)



Within the framework of the functional testing carried out to date, approx. 2400 operating hours have been logged with the single-cylinder engine and approx. 1400 hours with several 12-cylinder models. Even without an appropriate endurance test programme it was possible to confirm that no concept-sourced defects exist. The minor shortcomings registered could be easily rectified.

Accumulated Hours Run



In many ways the 880 engine series meets essential prerequisites for reduced logistics support requirements. The wide power band covered by these engines allows, for the first time, logistically common motorization of a complete vehicle generation; from the lightest to the heaviest armoured vehicle, whether wheeled or tracked.

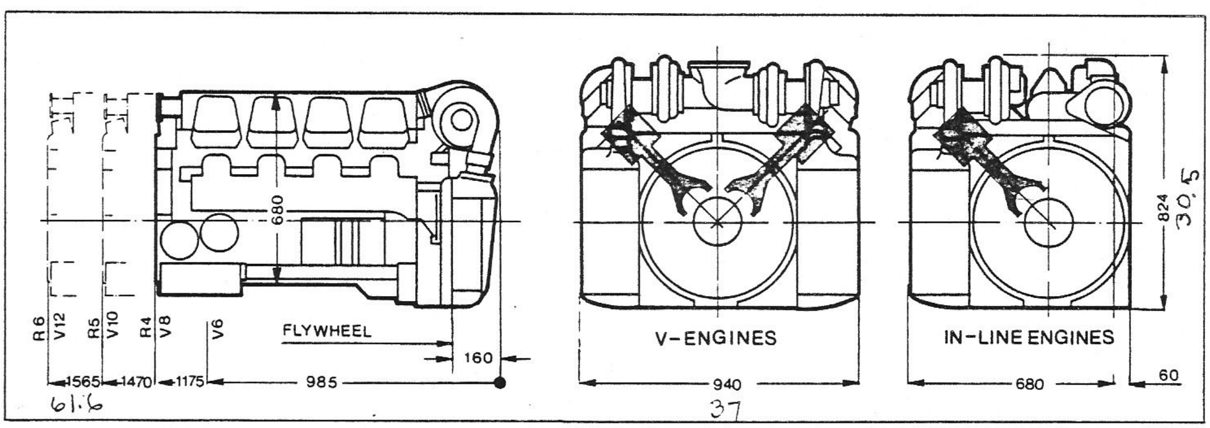
The 12-cylinder engine will meet all know power requirements for today's, and future, battle tanks and the 10, 8 and 6-cylinder V-engines will satisfy all medium-range power demands.

In addition, it is possible to provide light vehicles, with power requirements of 500 to 750 mHP, with an in-line engine version from the same engine series which assures technical commonality and considerably simplifies spare parts holdings. By the same token special tools, repair instructions and, by no means least, the know-how gained during development, production, utilization and maintenance is applicable to a wide range of vehicle types.

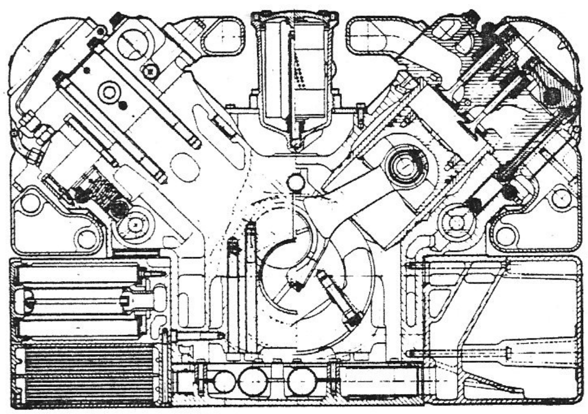
As has already been mentioned, it has been possible to considerably reduce the number of components, and thus the logistics support requirements, in comparison to engines with the same power ratings already in service. Thus, for instance, the Series 880 engines no longer incorporate a cylinder head gasket; sealing is by direct metal-to-metal contact. Furthermore, external coolant and oil pipework has been deleted.

Furthermore several components which have, until now, been different, such as inlet and exhaust valves or inlet and exhaust push rods are now identical. This is also true for the unit injection pumps with associated H.P. fuel lines which are identical for all engine models whereas previously a different block-type pump was required for each number of cylinders.

Main Dimensions, In-line and V-engines



Cross Section



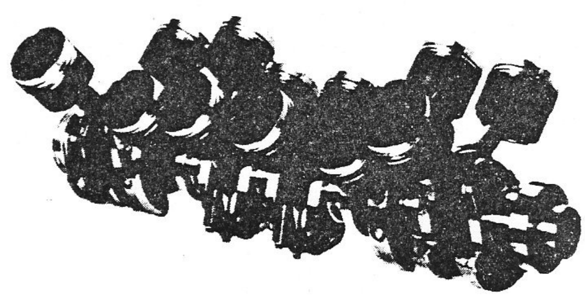
To reduce space and weight, particular care was taken to keep the pipework connecting the various sub-assemblies as short as possible. Thus, for instance, the oil cooler and oil filter have been combined into a single unit, the coolant manifolds have been integrated into the cylinder heads and the lengths of both the combustion air and exhaust pipework minimized. Hose lines have been completely eliminated.

Above all, the total number of components required has been considerably reduced in comparison to the tank engines now in service. The resultant advantages are favourable for both reliability and logistics.

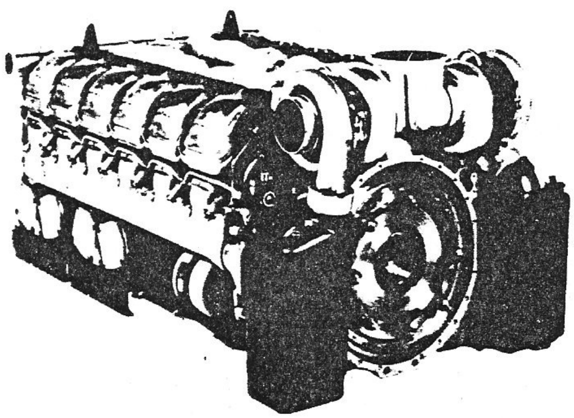
During the design phase, special emphasis was laid on the use of series-standard materials and production methods and that the mechanical and thermal loads on the individual components were maintained at proven levels.

Equal importance was attached to the arrangement and construction of the various functional groups. Novel design solutions were thus found for the connecting rods and the crankshaft counterweights which resulted in extremely small crankshaft chambers. Unit injection pumps were assigned to each individual cylinder and located, in the otherwise unused space, between the cylinder heads; injection pump drive is direct from the camshaft. The inlet and exhaust valves are identical and are actuated via three push rods. This allows extremely low valve gear dimensions and distributes the actuating forces equally between the roller tappets. The dry-sump oil pan, with side-mounted oil tank, is extremely flat and meets all operational requirements for inclined vehicle positions. As a matter of course, all sub-assemblies such as oil pumps, coolant pump and generator are gear-driven, the drive gear shafts being supported in ball bearings. As with the other tank engines, the crankcase is of cast aluminium and the main bearing caps are of forged steel. The individual grey cast-iron cylinder heads can be supplied for both pre-chamber and direct fuel injection.

Running Gear for 12 Cylinder Engine MT 883



12-Cylinder Engine MT 883



The 10, 8 and 6-cylinder V-configuration versions were based on the 12-cylinder engine and these, in turn, led to the development of the 6, 5 and 4-cylinder in-line models so that in future the 500 to 1500 mHP power range can be covered by a technically highly attractive engine series with common, standardized logistics requirements.

The arrangement of the sub-assemblies required for engine operation is determined in consideration of the engine being an individual part of the complete propulsion system of an armoured vehicle. Thus, for instance, a generator with a max. electrical output of 23 kW can be included within the engine envelope. Furthermore, the positions of turbochargers and intercoolers can be matched to the in-vehicle combustion air and exhaust systems. A particular advantage in this respect is the arrangement of the exhaust pipework in the engine saddle.

Main Data

		125 mHP per cylinder						
		In-line engines			90° V-engines			
Engine Type		**MT 884**	**MT 885**	**MT 886**	**MT 880**	**MT 881**	**MT 882**	**MT 883**
No. of cylinders		R 4	R 5	R 6	V 6	V 8	V 10	V 12
Displacement	l	8.4	10.5	12.6	12.6	16.7	20.9	25.1
Bore	mm	140	140	140	140	140	140	140
Stroke	mm	136	136	136	136	136	136	136
Engine Speed	rpm	3000	3000	3000	3000	3000	3000	3000
Power	metric HP	500	625	750	750	1000	1250	1500
Mean Effective Pressure	bar	17.6	17.6	17.6	17.6	17.6	17.6	17.6
Mean Piston Velocity	m/s	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Installation Volume	dm^3	531	628	701	674	804	878	975
Dry Engine Weight	kg	800	940	1050	1010	1220	1430	1650

That there ist still a lot of room for diesel engine development based on designer's know how and not on exotic technical solutions has been clearly demonstrated by the recent advances made by MTU with engines for military applications.

On-going development of MTU's Series 837 engines, introduced 30 years ago, led first to the Series 870 and now, as a logical step forwards, to the Series 880. Increased power ratings with improved fuel consumption, considerably reduced installation volumes and substantial reductions in logistics requirements are but a few of the characteristics which make these engines particularly attractive for both new vehicle generations and repowering projects.

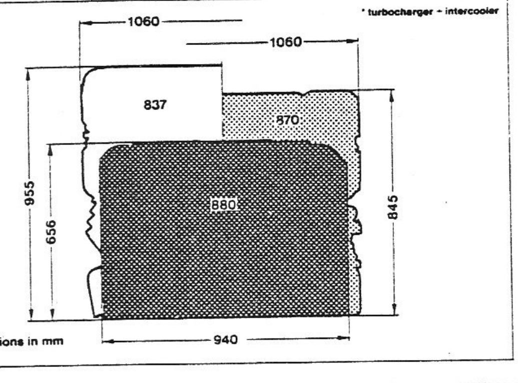
Introduction

The technical concepts of the Series 837 engines were laid-down in the mid-fifties. To date more than 14000 of these 6, 8 and 10-cylinder, liquid-cooled, V-configuration engines have been delivered. They have proven extremely successful in practical service in a great number of different types of vehicles as naturally aspirated, mechanically supercharged or turbocharged engines.

Comparison, Series 837-870-880

Series	837		870	880
Cylinder displacement	3.74 Liter		3.97 Liter	2.09 Liter
Supercharging	mech.	ATL + LLK*	ATL + LLK*	ATL + LLK*
Rated speed	2200 rpm	2400 rpm	2600 rpm	3000 rpm
Cylinder output	83 mHP	125 mHP	150 mHP	125 mHP
M. E. P.	8.9 bar	12.3 bar	12.8 bar	17.6 bar
Mean piston speed	12.8 m/s	14.0 m/s	15.2 m/s	13.6 m/s
Power-to-volume ratio	545 mHP/m^3	680 mHP/m^3	1090 mHP/m^3	1500 mHP/m^3
Change	–	+ 25 %	+ 100 %	+ 175 %
Weight-to-power ratio	2.0 kg/mHP	1.6 kg/mHP	1.2 kg/mHP	1.1 kg/mHP

* turbocharger + intercooler



Dimensions in mm

Development of the second-generation tank engine, the Series 870, started in the mid-sixties. With reduced external dimensions and higher cylinder power ratings it has considerably higher power utilization than the Series 837. The 12-cylinder MB 873 engine with 1500 mHP for the Leopard 2 and the 8-cylinder MB 871 with 1200 mHP are currently in series production.

Since the mid-seventies, MTU has been working on the third-generation tank engine, the Series 880. With these engines the installation volume has again been considerably reduced so that, in future, engines with extremely small external dimensions will be available to cover the 500 to 1500 mHP power range. For instance, the 12-cylinder MT 883 engine has the same power rating as the Leopard 2 engine but requires only 60 % of the installation space.

Technical Concept

The design of this new engine series was based on the fact that the mean piston speed should be maintained at a level which had already been introduced, and proven, in series production but that the Mean Effective Pressure (MEP) – the second important design parameter for reciprocating piston engines – could be raised without exceeding mechanical or thermal load limits.

An additional design condition was that the highest power rating required for battle tank propulsion should represent the optimum for the engine series. The 12-cylinder version was selected for this purpose as it offers the most favourable power-to-weight and power-to-volume ratios. Together with the bore/stroke relationship determined by design considerations, this led to a cylinder displacement of 2.09 liters with a bore of 140 mm and a stroke of 136 mm.

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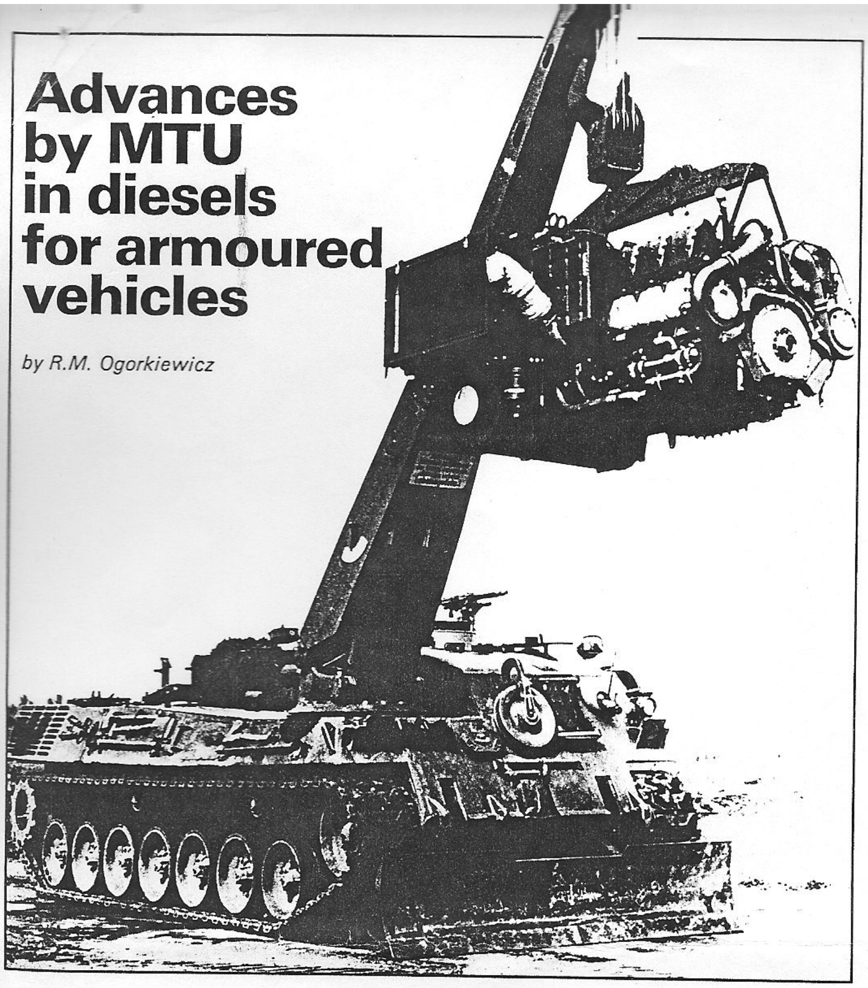
Advances by MTU in diesels for armoured vehicles

by R.M. Ogorkiewicz



▲ A *Leopard* armoured recovery vehicle hoisting a *Leopard* 1 power pack. This photograph clearly shows the MB 838 Ca-M engine.

Progress in the design of tanks and other armoured vehicles depends, to a considerable extent, on the development of new, or at least improved, components. Of these, engines, which are almost universally diesels, are among the most important. Advances in diesel engine technology are of considerable significance to the development of armoured fighting vehicles as well as being of interest in their own right. This is especially true of advances made recently by Motoren- und Turbinen-Union Friedrichshafen, which occupies a leading position in the field of diesels for armoured fighting vehicles.

The most important single advance achieved recently by MTU is undoubtedly the development of the MT 883, a new, high-output engine. This advanced new diesel has not, however, been developed in isolation but on the basis of extensive experience with several other, earlier engines which continue to be developed further. Moreover, the MT 883 engine has been accompanied by other developments, which also deserve attention.

MB 837 engine family

The earliest of the MTU diesels for armoured vehicles is the MB 837. The development of this V-8 engine was started in 1953 by Daimler-Benz AG, Stuttgart, as part of a family of high-performance diesels intended mainly for automotive applications. It found its first application in an armoured vehicle when the Swiss Army decided to adopt it in 1957 for its indigenous tank, the Pz61. To meet the power requirements of this tank, the MB 837 was fitted with a single, mechanically driven centrifugal supercharger and developed 463 kW (630 metric hp).

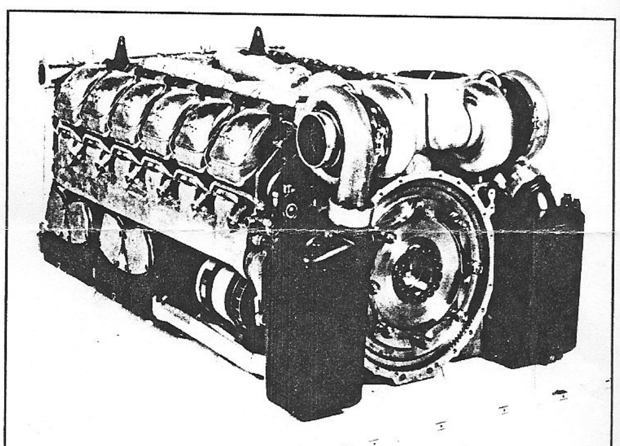
A little later, the MB 837 was also adopted for the *Jagdpanzer Kanone* (KJPz 4-5), the prototypes of which were ordered for the Federal German Army in 1960. In this case, and subsequently in the *Jagdpanzer Rakete* (RJPz 2), the MB 837 was used in its naturally aspirated form and developed 370 kW (500 metric hp).

The adoption of the MB 837 for these two series of armoured vehicles was followed by the development of a more powerful version with two more cylinders, the V-10 MB 838, which was adopted for the *Leopard* 1 battle tank and its derivatives. Like the MB 837 Ba of the Pz61, the MB 838 Ca-M of the *Leopard* 1 was supercharged, having one mechanically driven centrifugal supercharger for each bank of five cylinders and producing 610 kW (830 metric hp).

The third member of the family to be developed was the V-6 MB 833 which was adopted for the *Marder* armoured infantry vehicle. As originally installed in the prototypes of the *Marder* in 1962, the MB 833 had a single, mechanically driven supercharger, like the MB 837 Ba. However, by the time the *Marder* went into production in 1971, the MB 833 used in it was fitted with two exhaust-gas-driven turbo-superchargers, which are thermodynamically more efficient than mechanically driven superchargers and which gave the engine an output of 440 kW (600 metric hp).

Since it was put into production for the *Marder*, the MB 833 has been developed further. In particular, during the seventies a new version of it was fitted with a charge-air cooler, as a result of which, and with some increase in its maximum speed, its output was raised to 530 kW (720 metric hp). This new version has been adopted for the TAM tank and its companion infantry vehicle, the VCTP, developed for Argentina. The latest 530-kW (720-hp) MB 833 Ka-500 is also suitable for installation in the AMX 30 tank series.

There is also an up-rated 550-kW (750-metric-hp) version of the MB 837 with two turbo-superchargers, which is suitable for installation in US-built M47 and M48 tanks. The 550-kW (750-hp) MB 837 Ea-500 was tested extensively, in M47 tanks by the Italian and Pakistan armies in 1967-68 and 1970-71, respectively, and in an M48 by the Turkish Army, which is now to have it retrofitted in a number of its M48 tanks. The original MB 837 Ba has been produced not only for the Pz61 but also for its successor, the Pz68. The MB 838 Ca-M, which continues to be produced for the *Leopard* 1 series, can be installed in British-built *Centurion* tanks in place of the spark-ignition engines that some of them still have.



► Photograph of one of the three prototypes of the new, very compact MT 883 engine. This V-12 already develops 1500 hp but is expected to develop 1850 hp, if required. The metre rule shows how compact the engine is.

As it is, more than 12,000 engines of the MB 837 family have already been built and their production is likely to continue for some time to come.

Common characteristics and components

All the engines of the MB 837 family have the same basic features and share many components. Thus they are all four-stroke, water-cooled diesels with pre-combustion chambers and banks of cylinders arranged in a 90° V. The cylinders are all of the same size, having a bore of 165 mm, the cylinder heads are separate but are the same for the different engines and all engines of the family have the same piston stroke of 175 mm. This high degree of commonality greatly simplifies the supply of spare parts and logistic support.

At the same time the engines of the MB 837 family are relatively light, because much of them and, in particular, their crankcases are of aluminium alloys. However, the crankcases are fitted with robust, wet, steel cylinder liners. Several other features also contribute to the robustness of the engines of the MB 837 family. One of them is their pre-combustion chamber system, which allows the use of fuel injectors with single holes instead of the more vulnerable multi-

▼ The V-6 MB 833 of the type fitted in the *Marder*. The photograph below it portrays more accurately the size of this engine as part of the power pack.

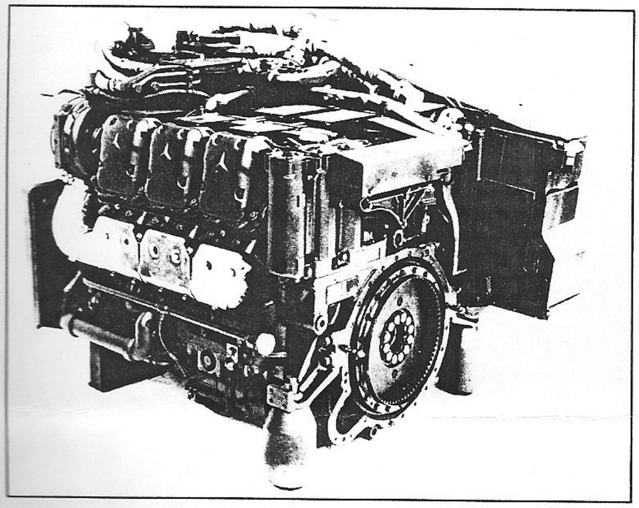
▼▼ The V-6 MB 833 fitted in a production *Marder*. This version of the engine is fitted with two exhaust-gas-driven turbo-superchargers and produces 600 metric hp (400 kW).

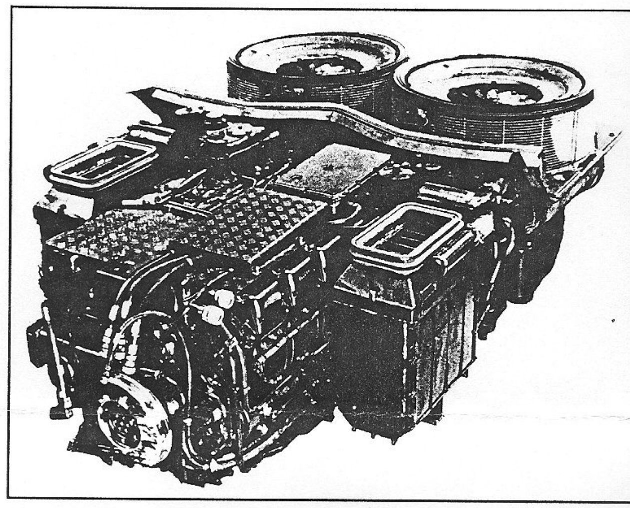
► Transverse section of the MT 883 engine which shows its precombustion chamber and how its designers have made full use of the available space to keep down its size.

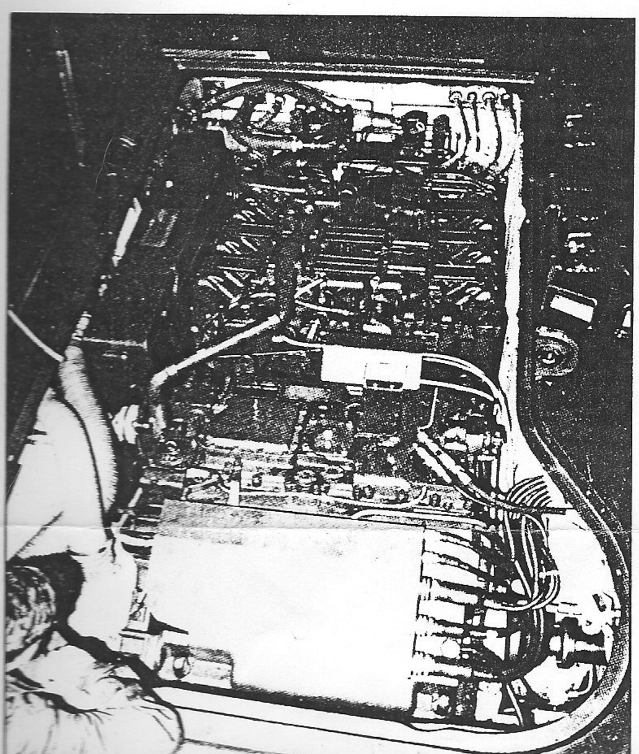
►► Diagram of the BKS combustion-chamber-assisted turbo-supercharging method applied to a bank of six cylinders and curves showing how much more rapidly torque builds up with BKS compared with engines without it.

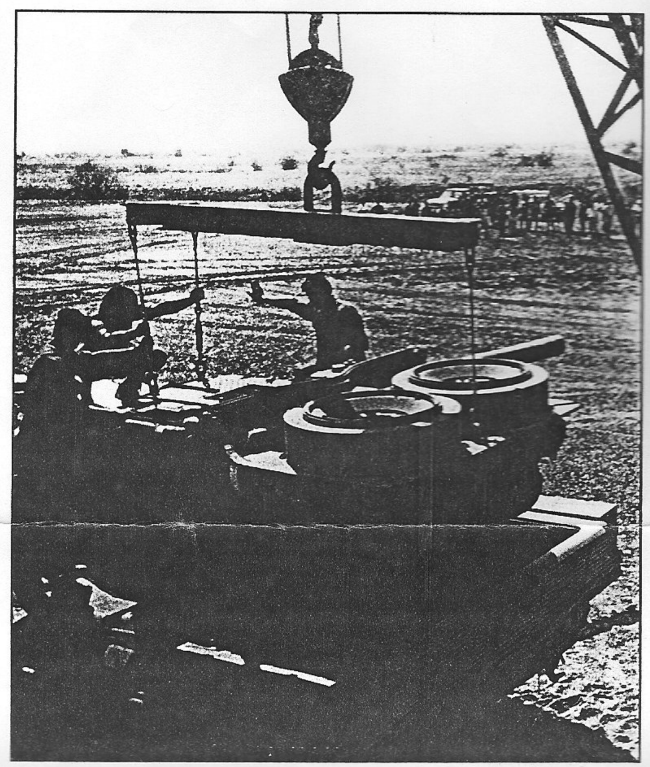
▼ Power pack of the *Leopard* 2 battle tank consisting of MB 873 Ka-501 engine, Renk HSWL 254 transmission and specially developed annular radiators which surround the two cooling fans. In addition to developing engines, MTU have been heavily involved in the design and development of such integrated power packs.

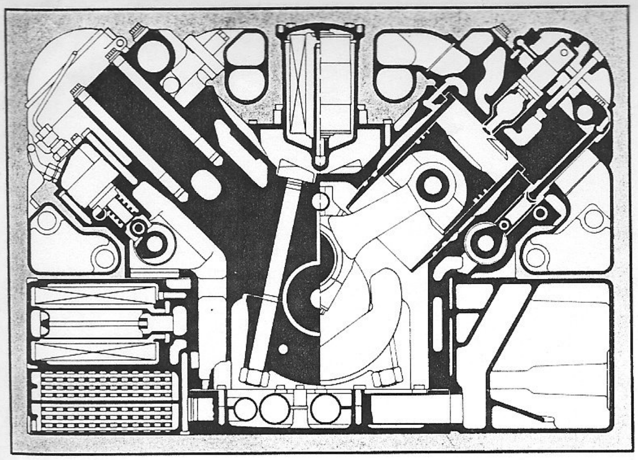
▼▼ A *Leopard* 2 pack change being carried out in the field, during trials at the Yuma Proving Ground, Ariz. USA. This photograph gives a clearer indication of the size of this power pack than the photograph above it.

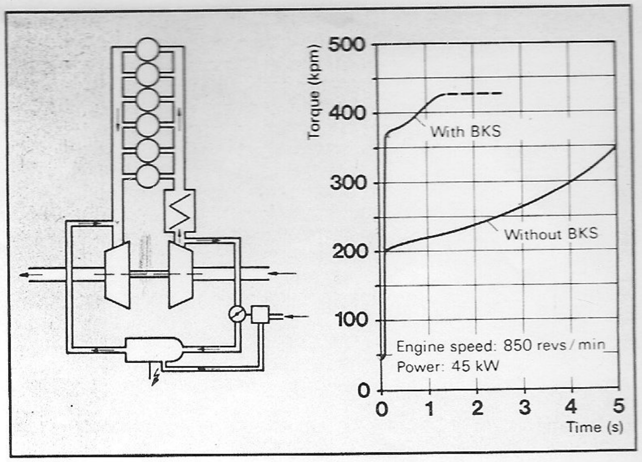












hole injectors required by other combustion systems. Another important factor is the relatively modest brake mean effective pressure and, therefore, output per unit of cylinder swept volume. The progressive increases in the degree of supercharging through the application of mechanically and then of exhaust-gas driven superchargers have, of course, increased the brake mean effective pressure but even the most highly rated engine of the family, the MB 833 Ka-500, still has a maximum brake mean pressure of no more than 13.4 bars (194 psi).

Relatively modest brake mean effective pressures might be taken to imply that the engines are fairly bulky. However, their bulk has been minimised by the attention paid in their detail design to making them compact, which the writer as a one-time diesel development engineer finds particularly admirable. Other praiseworthy features of the MB 837 engines and of their installations include the absence of hoses, all fluids being conveyed by metal pipes, and an absence of belt drives for the auxiliaries, which are driven instead by shafts and gears.

MB 870 family

The basic features of the MB 837 family of engines have been retained in the MB 870 series which has followed them, incorporating further improvements and, in particular, producing more power in relation to their size.

The development of the second family of engines started in 1965 with the MB 873, a V-12 engine which was designed for the US-German MBT-70, as an alternative to the Teledyne Continental AVCR-1100. In principle, its design was much the same as the engines of the MB 837 family and it even had the same cylinder bore of 165 mm, although its stroke of 155 mm was less. However, it was considerably more compact as its overall height was only 825 mm, compared with 955 mm of the earlier engines, while its width was the same. Moreover, it was fitted from the start with two turbo-superchargers and charge-air cooling, which resulted in it having a maximum brake mean effective pressure of 13.6 bars (197 psi). In consequence, it developed 1,110 kW (1,500 metric hp) at 2,600 rpm out of a swept volume of 39.8 litres.

Because it was based on well proven design features of the earlier family of engines, the development of the MB 873 proceeded with remarkable speed, so much so that by 1967 it had already passed the demanding 400-hour NATO engine test. Subsequently, it performed well in the German prototypes of the MBT-70 in which it was installed. Although the development of MBT-70 came to nothing, that of the MB 873 continued after 1969 for the *Leopard* 2 battle tank.

At first, the engine fitted in the *Leopard* 2 prototypes was much the same as that in the MBT-70. However, to improve its torque and, therefore, to increase the acceleration of the tank, it was decided in 1977 to increase the bore and stroke of the engine to 170 and 175 mm, respectively. As a result, the swept volume of the new MB Ka-501 version increased to 47.6 litres and this was used entirely to increase the torque of the engine, since its maximum power was kept at the original 1,110 kW (1,500 metric hp) level. In fact, the maximum torque increased from 4,300 Nm at 1,950 rpm to 4,700 Nm at 1,600 rpm, in spite of a reduction in the maximum brake mean effective pressure from 13.6 to 12.4 bars (197 to 180 psi). In other words, the new version produced more torque at a lower speed, a requirement for high vehicle acceleration. At the same time, the reduction in the mean effective pressure meant that less was demanded from the turbochargers and, consequently, the response of the engine was improved. As a result, the *Leopard* 2 fitted with the MB 873 Ka-501 not only has a power-to-weight ratio of 20 kW/t (27 metric hp/t) but can accelerate from 0 to 32 km/h (0 to 20 mph) in less than 6 seconds.

A very significant reduction was also achieved in the specific fuel consumption of the engine. Whatever their other virtues, engines with pre-combustion chambers are not generally noted for a low fuel consumption, but the minimum achieved with the MB 873 Ka-501 is 213 g/kW/h (157 g/metric hp/h). This is not only significantly lower than the minimum of 234 g/kW/h (172 g/metric hp/h) of the original Ka-500 version but is almost as low as the minimum specific fuel consumption of good direct-injection engines.

Apart from its successful application in the *Leopard* 2 battle tank, the MB 873 has also been developed into a higher-output version in anticipation of future needs. This has resulted in an 1,800-metric-hp engine which passed the 400-hour NATO test in 1976. Since 1970, a V-8 version, the MB 871, has also been developed for SP 70, the Anglo-German-Italian 155-mm self-propelled gun. It has the same output per cylinder as the MB 873 Ka-501 so that its total gross output is 735 kW (1,000 metric hp).

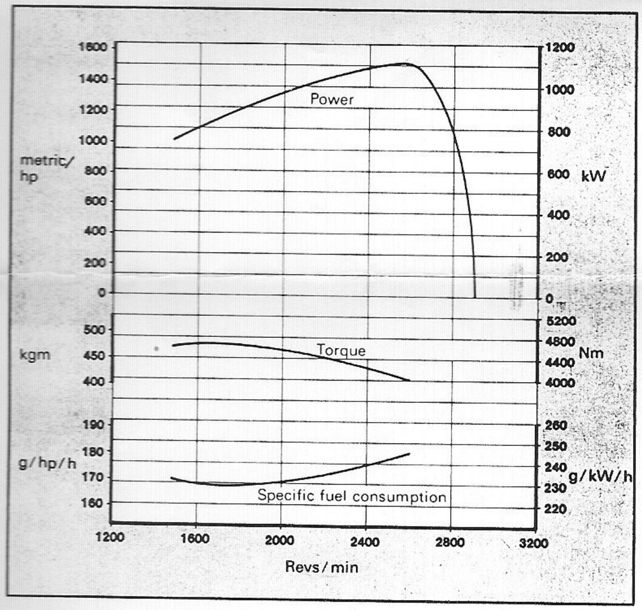
New MT 880 family

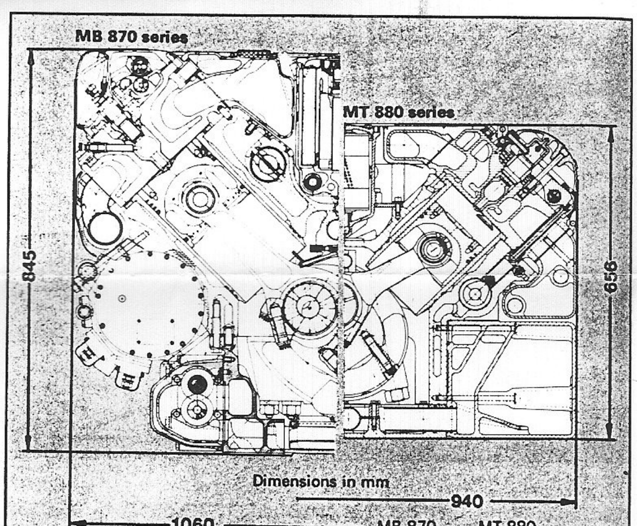
Engines of the MB 873 family were originally built by Daimler-Benz at their plant in Stuttgart-Untertürkheim, but since 1962-63 all engines of both the MB 837 and MB 870 series have been built in Friedrichshafen in what was originally a Maybach-Motoren GmbH plant. This famous engine company which was responsible, among other things, for the HL series of engines used in almost all German tanks of World War II, including the *Panthers* and *Tigers*, merged in 1966 with the high-performance-diesel division of Mercedes-Benz, and in 1969 the merger was extended to the corresponding division of MAN. This resulted in the formation of the Friedrichshafen branch of Motoren- und Turbinen-Union.

Yet, in spite of all this, there was no loss of continuity in the development of engines and of the experience which is so vital to their success. In fact, the development of the latest engines is being carried out in Friedrichshafen by basically the same team of engineers as the one which started the original MB 837 family in Stuttgart.

Since it came into existence in 1969, MTU-Friedrichshafen has continued to produce and to develop further the engines originated by its predecessors. However, its management was not content only to exploit the success of the existing designs and, soon after its formation, started work on a new family of engines to meet future needs. The work was actually started in 1970 and has since led to the MT 883 engine, which is the most attractive engine for armoured vehicles to be developed anywhere so far.

The most remarkable feature of the MT 883 is its compactness, which is all the more remarkable for having been achieved without the use of exotic materials. In some respects, the MT 883 might not seem very different from the MB 837 and MB 873 engines, and its design makes full use of all the experience acquired with the earlier engines, which augurs well for its development. However, while it resembles the earlier engines in being a water-cooled, four-stroke diesel with a 90° V-configuration and in having basically the same pre-combustion chamber system, its specific bulk even at its present rating is only 60 percent of that of the MB 873, and likely to be less still with





		MB 870	MT 880
Power-to-weight ratio	(metric hp/kg)	1.19	1.33
	(kW/kg)	.88	.98
Power-to-volume ratio	(metric hp/m³)	1400	1800
	(kW/m³)	1030	1325

further development. Its overall height is only 656 mm and its width 940 mm, while its length is 1,565 mm, in spite of being a V-12 with a cylinder bore of 140 mm and a stroke of 136 mm.

The principal reason for the small overall dimensions of the MT 883 is careful mechanical design. This has involved the adoption of a crankshaft having counter-weights with a small outside radius, which has allowed the use of relatively small, flat connecting rods and reduced the size of the crankcase. Other features which have contributed to the small overall dimensions include a very shallow, dry sump and the design of the valve gear with very short push rods and single rocker arms for the two exhaust valves in each cylinder head but only a single double rocker for the two inlet valves.

The MT 883 also has individual, camshaft-operated fuel injection pumps which are located between the cylinders on the inlet side. This has freed the space within the V formed by the two banks of cylinders, which is normally occupied by an in-line injection pump, for the exhaust manifolds, so that the latter no longer need room elsewhere. Moreover, having the exhaust manifolds in the middle of the V means that the sides of the engine are considerably cooler and this makes it much easier to install the MT 883 alongside a driver's compartment or a transmission, which are the best locations for the engine in some armoured-vehicle designs.

The advantages which result from the compactness of the MT 883 are perhaps best illustrated by the fact that, if it were installed in a *Leopard* 2 in place of its current MB 873

▲◄ Performance curves of the MB 837 Ka-501 engine of the *Leopard* 2: top, horse power; middle, torque; bottom, specific fuel consumption, all plotted against engine speed. The very favourable torque curve is particularly worth noting.

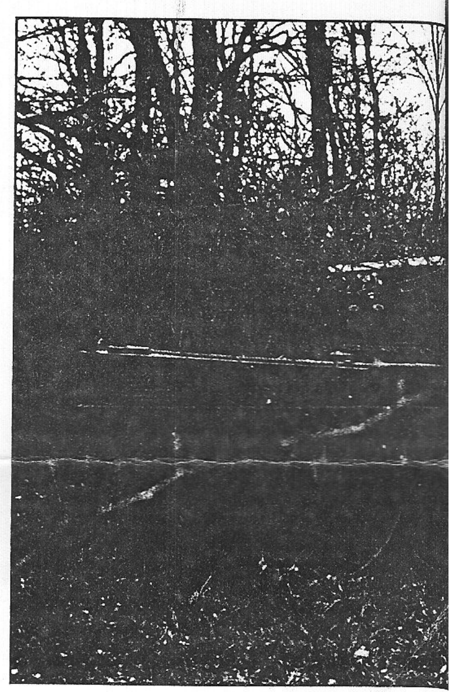
▲ Comparison of the transverse sections of the current MB 870 engines and of the new MT 880 series, which shows clearly how much smaller the new engines are.

► Diagrams which indicate to what extent the engine compartment of an armoured vehicle could be reduced if one of the existing engines were replaced by engines of the MT 880 series, even though the latter produce much more power. The vehicle considered is the *Marder* infantry vehicle, which is at present powered by the 600 hp MB 833 Ea, and the new engines are the MT 880 Ka, 900 hp V-6 and the MT 881 Ka, 1200 hp V-8.

▼ *Leopard* 2.

Principal characteristics of representative MTU diesels

Model	MB 833 Ea	MB 833 Ka-500	MB 837 Ea-500	MB 838 Ca-M	MB 873 Ka-501	MT 883
Configuration	V-6	V-6	V-8	V-10	V-12	V-12
Bore, mm	165	165	165	165	170	140
Stroke, mm	175	175	175	175	175	136
Swept volume, litres	22.4	22.4	29.9	37.4	47.6	25.1
Compression ratio	19.5:1	18:1	18:1	19.5:1	18:1	16:1
Superchargers	2 turbo-chargers	2 turbo-chargers + charge air coolers	2 turbo-chargers	2 mechanically driven	2 turbo-chargers + charge air coolers	2 turbo-chargers + charge air coolers
Max. gross power:						
metric hp (DIN)	600	720	750	830	1,500	1,500
English hp	592	710	740	819	1,479	1,479
kW	442	530	552	611	1,104	1,104
Max. speed, rpm	2,200	2,400	2,300	2,200	2,600	3,200
Max. mean piston speed, m/s	12.83	13.96	13.41	12.83	15.2	14.5
Max. bmep:						
bars	11.2	13.4	10.6	9.5	12.4	19
psi	162	194	154	138	180	284
Speed at max. bmep, rpm	1,600	1,900	1,600	1,550	1,600	1,900
Min. specific fuel consumption:						
g/metric hp/h	155	160	156	158	157	158
lb/hp/h	0.35	0.36	0.35	0.35	0.35	0.35
Mass, dry:						
kg	1,250	1,300	1,420	1,730	2,590	1,300
lb	2,755	2,866	3,130	3,813	5,708	2,865
Vehicle	Marder	TAM	M48	Leopard 1	Leopard 2	—



engine, the hull could be shortened to such an extent that only six road-wheel stations on each side would be necessary. Equally striking reductions in the volume of the engine compartment and, therefore, in the size of armoured vehicles could be made with V-6, V-8 and other engines which have been proposed from the basis of the MT 883, to form a very comprehensive MT 880 family of engines.

So far, three MT 883 engines have been built. The first ran in 1967 and developed 880 kW (1,200 metric hp), using a turbocharger for each bank of six cylinders and a charge-air cooler. Since then, the output of the MT 883 has been raised to 1,100 kW (1,500 metric hp) without sacrificing the engine's thermal efficiency, which is demonstrated by the fact that the minimum specific fuel consumption is 215 g/kW/h (158 g/metric hp/h). Eventually, the MT 883 is expected to develop 1,400 kW (1,850 metric hp).

Until now, the development of the MT 883 and the rest of the MT 880 family has been pursued by MTU entirely as a private venture. However, it is believed that at least some of the work involved in it is to receive financial support from the Federal German Government, as it should in view of the potential advantages of using engines of the MT 880 family in armoured vehicles. In fact, MT 883 is the strongest candidate to have emerged so far for the engine of any future battle tank.

Further developments

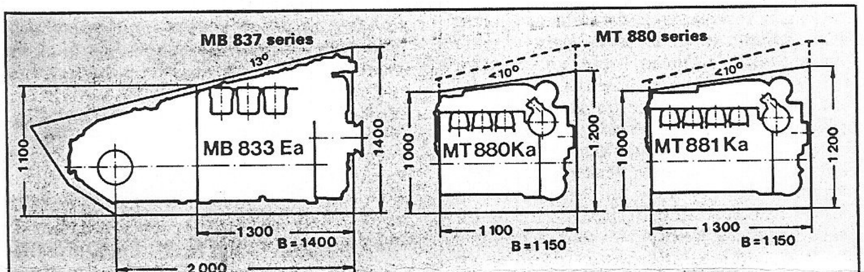
In general, further development of diesels by MTU is aimed at increasing specific output through still higher brake mean effective pressures. The MT 883 already has a mean effective pressure of 16.5 bars (239 psi) at maximum power, but when its output is raised from 1,100 to 1,400 kW (1,500 to 1,850 metric hp) this will rise to 20 bars (290 psi). However, even higher mean effective pressures, of up to 30 bars (435 psi), are contemplated for further engines.

The operation of diesels at such very high mean effective pressures requires a reduction in their compression ratio, and this creates problems at starting and while idling. To overcome them, MTU have devised a cylinder charge transfer system which involves cutting off the supply of fuel to some of the cylinders of an engine and transferring the air compressed in them to the firing cylinders. This improves the combustion in the latter under light loads and while idling. The charge transfer system still has to be applied to automotive engines but it is already being tested in other engines.

Another problem raised by very high mean effective pressures is the difficulty of achieving satisfactory matching between the turbochargers and the engine over the whole of its operating range. To solve this problem, MTU has been working on a sequential turbocharging system which involves the use of two turbochargers per bank of cylinders and bringing them into action one after the other. Sequential turbocharging may be regarded as a form of variable-geometry turbocharging which, in its straightforward form, has already been tried in tank engines and is also being investigated by MTU. Unlike some other variable-geometry turbochargers, however, those being developed by MTU only have variable turbine-nozzles which are considered sufficient and involve less complication because the geometry of the turbocharger compressor is fixed.

The most important practical advantage offered by variable-geometry turbochargers is an improvement in the acceleration of the engine and, consequently, of the vehicle. Engine response can, however, be improved in other ways, in particular by the BKS or *Brennkammersystem* developed by MTU. Superficially, this bears some resemblance to the *Hyperbar* system developed in France in having an auxiliary combustion chamber to supply additional energy to the turbine of the turbochargers and, therefore, to make the latter build up the pressure on the induction side of the engine more quickly. However, the BKS combustion chamber works in parallel with the flow of air and exhaust gases through the engine, whereas in the *Hyperbar* system the combustion chamber works in series with the engine. This means that with BKS the combustion chamber is switched on only to accelerate the engine and is not used continuously to boost its brake mean effective pressure. In consequence, the engine can be started without it, and it is simpler than the other systems with auxiliary combustion chambers. It also imposes no penalty in terms of fuel consumption, which was demonstrated when the BKS was first tested in 1976 fitted to the MB 873 engine of one of the *Leopard* 2 prototypes.

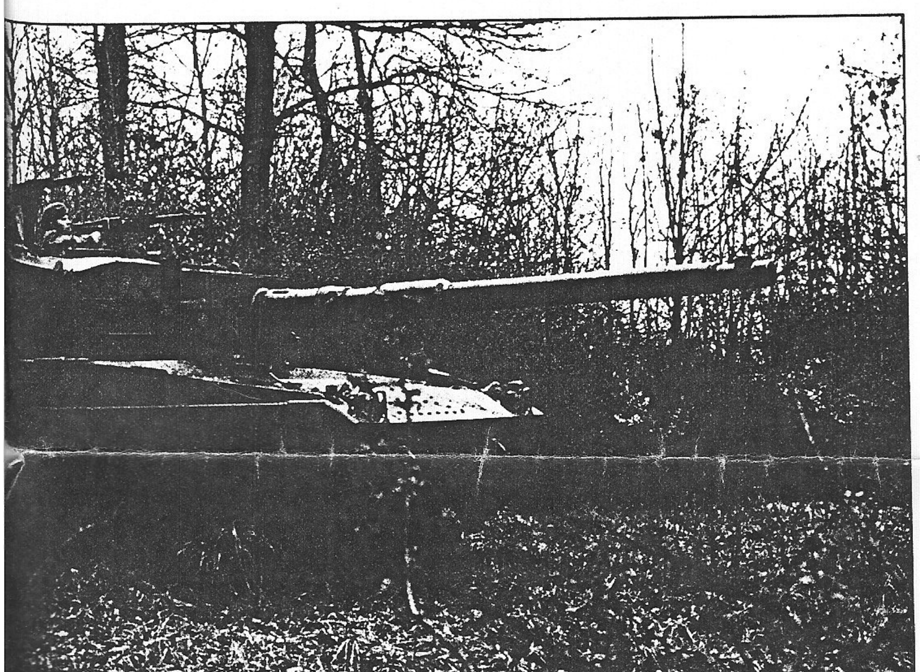
In spite of all the effort being devoted by MTU-Friedrichshafen to the development of diesels, the company's engineers are not ignoring the development of other engines and in particular that of automotive gas turbines. In fact, they are in close contact with it through the other company of the MTU Group, MTU-Munich, which is not only concerned with gas turbines for aircraft but which has been involved for some time, with other German companies, in a collaborative project aimed at developing gas turbines for trucks. As a result, MTU-Friedrichshafen clearly recognizes that gas turbines offer a number of potential advantages for armoured vehicles. However, they are also well aware of their shortcomings. Thus, in spite of the claims that continue to be made elsewhere, they are of the opinion that gas turbines are still nowhere near being superior to diesels for armoured vehicles—a verdict with which it is difficult to disagree. ++



Power	440 kW/600 metric hp	660 kW/900 metric hp	880 kW/1,200 metric hp
Bulk Volume[1]	1.8 m³	1.05 m³	1.24 m³
Weight[1]	1,850 kg	1,350 kg	1,580 kg
Power-to-volume ratio	245 kW/m³	630 kW/m³	710 kW/m³

1 — Includes air filter and gearbox
B — Overall width

Dimensions in mm



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MTU

MB 873 Diesel Engine

MB 873 Diesel Engine

mtu

High Performance Diesel Engines
For
Armored Vehicles

Origin of the MTU companies

In the eighties, Gottlieb Daimler and Wilhelm Maybach built the first high-speed lightweight internal combustion engine in the world.

In 1886, Karl Benz presented independently his first motor car.

One year later, Rudolf Diesel constructed his engine with M.A.N. in Augsburg, and in 1909, Karl Maybach founded his Motorenbaugesellschaft in Friedrichshafen.

In 1966, Daimler-Benz merged its product division "high-performance diesel engines" with Maybach-Motorenbau, thus establishing the Maybach Mercedes-Benz Motorenbau GmbH out of which resulted MTU Friedrichshafen in July 1969, when the corresponding M.A.N. engine range was also transferred to the new company.

Continuing the previous tradition, MTU Friedrichshafen is leading today in the development and manufacture of high-speed high-horsepower diesel engines.

And what are the future prospects? The international market demands more and more powerful drives. Our engineering and production departments are working on these systems. Our aim: continuous enhancing of specific ratings, and even longer running periods.

History of the present tank engine generation

The tradition of the present MTU Friedrichshafen company in the construction of high-performance engines for the drive of military extra-heavy vehicles can be traced back to the early thirties. This means that from the actual origin of a modern tank force MTU and its predecessors Maybach or Daimler-Benz have been, and are still instrumental in designing the respective propulsion units.

Before and during World War II the Maybach HL-type engines were the selected standard propulsion units for tanks and prime movers of the earstwhile German Wehrmacht. The aforesaid power plants included water-cooled 6- and 12-cylinder engines in the power range from 100 to 700 hp, operating at speeds of between 2 800 and 3 000 rpm. These were all spark-ignition engines, as repeated investigations on a possible better suitability of the diesel engine had revealed a definite superiority of the spark-ignition engine, in consideration of the limited space available in tanks, and on the basis of the state of the art in those days.

The production of these engines was started in Friedrichshafen, where nearly one thousand 700 hp engines were produced per month. Subsequently, when quite a few other companies were manufacturing this particular engine type under license, the monthly output increased to several thousand units. By the end of the war, some 140,000 tank engines had left the assembly lines, representing an aggregate horsepower output of 40 million hp.

Furthermore, a considerable number of semi-automatic multi-speed transmissions were operated by the former German Wehrmacht in their tanks and prime movers.

Most of them were 8-speed transmissions requiring of the driver only the pre-selection of the desired speed, the actual shifting operation being fully automatic. Some 10,000 prime movers and a large number of light-armoured tanks as well as all the "Tiger" combat vehicles were fitted with this particular type of transmission.

The technological know-how relating to engines and transmissions was, when compared with the international standard, extraordinary enough as to cause the Allied Forces experts to focus their interest on it immediately after cessation of operations.

Subsequently, highly qualified German technicians were transferred from Friedrichshafen to France, and through their continued work on propulsion units for extra-heavy vehicles the comprehensive wealth of experience was not lost and could be used as a basis for new engine developments.

Military demands on a modern tank force involved, of course, changes in the propulsion plants, it being understood that the following requirements initiated the development of such compact high-horsepower engines as have been built since 1954 by the development teams now pooled in the MTU:

- high power concentration in a confined space;
- operational reliability at extreme service and climatic conditions;
- fire-proofing;
- large cruising range;
- multifuel capability, for operation on fuels of diverse octane numbers, and any mixture.

For the purpose of the above, MTU has constantly improved the devlopment of special engines, the basis of their success being the comprehensive experience in the construction of high-horsepower engines for most diversified applications, a technology always representing the latest state of the art, and last but not least the exceptional detailed knowledge regarding propulsion systems and military terrain vehicle types.

MTU engines and power packs for military tracked vehicles have the following features:

- compact design, small bulk and low weight;
- block-type configuration, i.e. the entire propulsion system is an integral unit that can easily be installed, removed, and operated outside of the tank;

- series design using the family concept, with different numbers of cylinders, involving standardisation for logistics purposes, with resultant coverage of vehicles of different power;

- long service life and reliability even under extreme operating conditions;

- low degree of maintenance efforts, and good accessibility to all maintenance points;

- operational reliability up to main overhaul;

- use of standardised military fuels

- multifuel capability enabling an operation on fuels of diverse octane numbers;

- cold starting capability and operation at extremely high ambient temperatures;

- inclination capability, i.e. the capability to start and operate the propulsion unit in any inclined position of the vehicle, without limitation as to time;

- exceptional operational behaviour at varying speeds and loads; rapid load assumption when the speed is raised from idling; satisfactory acceleration characteristics;

- deep fording ability, capability to operate and start the power plant under water; unsusceptibility of power unit to flooding;

- insensitivity to dust and sand erosion;

- shock-proofing of the entire power plant.

The start was a series of 6, 8 and 10-cylinder engines - the MTU MB 837 engine series - developing a bulk output of over 600 hp/m3 with a power-to-weight ratio of about 1.7 kg/hp. To date, more than 9,000 units of this particular engine series have been supplied as power plants for the present tank generation.

The MTU MB 870 engine series, the 6, 8, 10 and 12-cylinder versions of which cover the power range from 900 to 1,800 hp have been developed for the forthcoming generation of extra-heavy military vehicles. The weight per horsepower of about 1 kg and the bulk output of almost 1,100 hp/m^3 indicate the state of technological development that has actually been attained with these engines.

The previous development of MTU high-performance propulsion units for special military vehicles was marked by the following significant events:

1953 - Start of the development of the MB 837 engine series

- 8-cylinder MB 837 engine for Main Battle Tank 61 (Switzerland)
- 8-cylinder MB 837 engine for Destroyer Tank "Cannon" and its variants
- 10-cylinder MB 838 engine for Main Battle Tank "Leopard" and its variants
- 8-cylinder MB 837 engine for "Battle Tank 68" (Switzerland)
- 6-cylinder MB 833 engine for Armoured Infantry Combat Vehicle "Marten" and its variants
- 8-cylinder MB 837 engine for Flatbed Tank Transporter SLT 50

1965 - Start of the development of the high-performance multifuel MB 870 engine series

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- 12-cylinder MB 873 engine for German-American MBT 70 Program
- 10-cylinder MB 872 engine for "Leopard II" test rig
- 12-cylinder MB 873 engine for "Leopard II"
- 8-cylinder MB 871 engine for the German-British-Italian joint development of a self-propelled howitzer mounting

The MB 837 engine series

consists of liquid - cooled 6, 8 and 10-cylinder four-stroke 90° V diesel engines operating according to the pre-chamber method. All of theseunits have an identical bore and stroke.

The engine housing and its lower part serving for dry sump lubrication are light metal castings. The individual cylinder heads which are also light alloy castings, have detachable rocker arm housings. Two inlet and two exhaust valves are concentrically arranged around the central pre-chamber with injection nozzle and heater plug.

The plain bearing supported crankshaft and connecting rods are completely machined steel forgings. Mass equilibrium is effected through counterweights. The connecting rods are arranged in pairs on one crank pin for two cylinders located opposite each other.. The The diagonal splitting of the connecting rods enables the pistons and connecting rods to be removed through the cylinders. The oil - cooled pistons are light metal forgings carrying three compression and two oil control rings. The replaceable wet cylinder liners are inserted into the engine housing from above. At the main power output opposite end the engine housing forms the integral gear train casing.

The valves are controlled by one camshaft for each cylinder bank, through tappets, push rods and rocker arms. They are closed by two coil springs each.

From the delivery pump the fuel is supplied through a two-stage fuel filter to the injection pump arranged in the engine saddle. The governor is flange-mounted to the injection pump, the two elements being lubricated from the engine oil system. Drive of the injection pump is effected through a fuel injection timer.

The engines are provided with a dry sump forced-feed circulation lubricating oil system. The oil in the lower part of the engine housing is drawn off by two oil return pumps delivering it to an oil tank fitted to the engine. A pressure oil pump draws the oil from the tank and forces it to the different lubricating points, through the engine oil heat exchanger, filter and integrally cast oil ducts in the housing.

The design of the cooling system depends on the respective application, the system itself being pressurized. The coolant is circulated through the lubricating oil heat exchanger and engine cooling spaces, by means of a centrifugal pump mounted onto the gear train casing. A thermostat ensures a constant operating temperature. Re-cooling of the engine coolant is effected through an air-to-water cooling system.

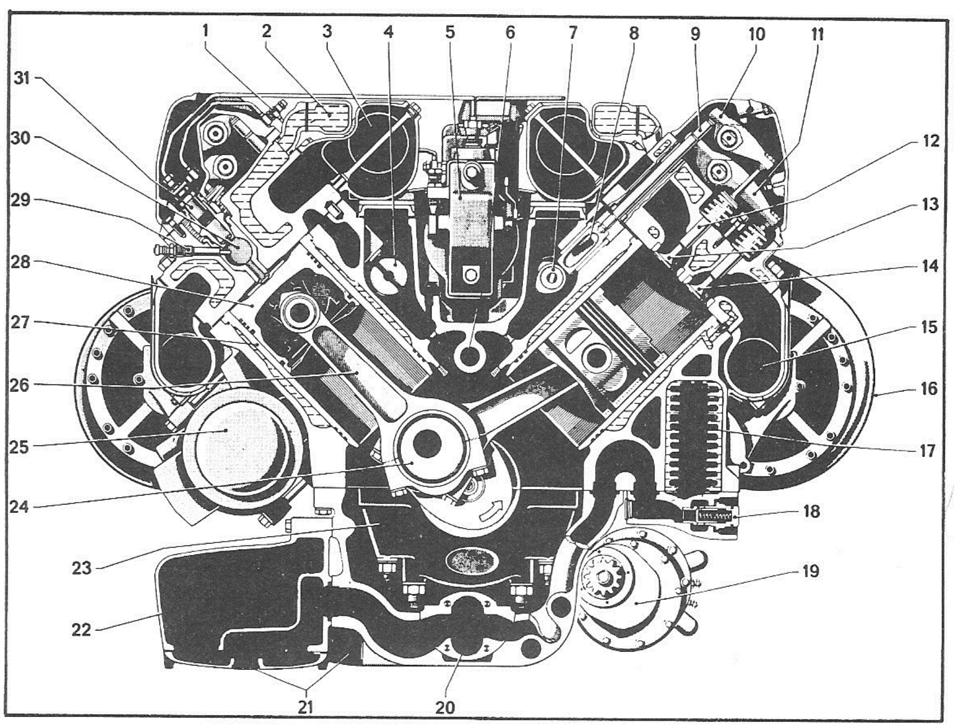
For an increased power output and an improved efficiency, the engines of this series are partly provided with a charging system which, according to the respective number of cylinders and application requirements incorporates one or two mechanical blowers that are driven through the gear train, or two exhaust gas turbochargers.

The MB 837 engine series covers the following standard designs:

MB 833 Ea	6-cylinder V-engine with two exhaust gas turbochargers
MB 837 Aa	8-cylinder V-engine, naturally aspirated
MB 837 Ba	8-cylinder V-engine with one mechanical blower
MB 837 Ea	8-cylinder V-engine with two exhaust gas turbochargers
MB 838 CaM	10-cylinder V-engine with two mechanical blowers

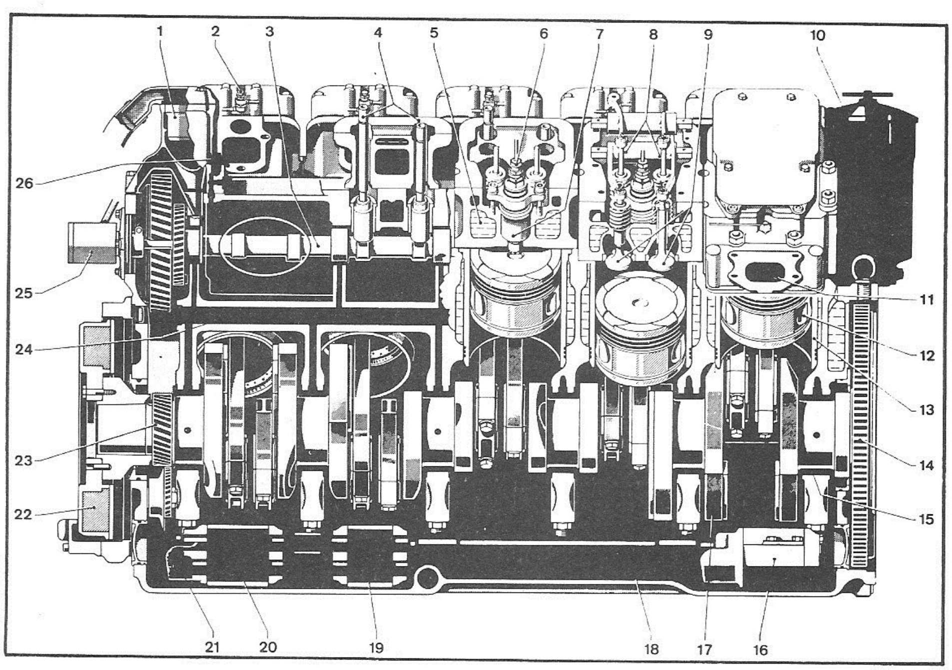
MB 838 Ca-M 500 cross-sectional view

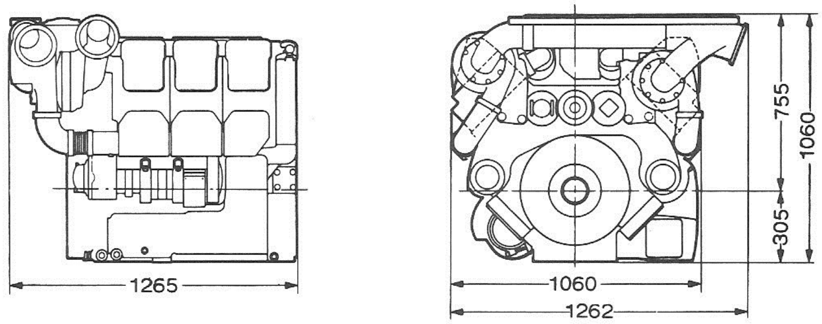
1 Leak-off fuel collecting line
2 Coolant collecting line
3 Charge air manifold
4 Camshaft, left, bearing
5 Injection pump with governor
6 Oil gallery
7 Camshaft, right
8 Tappet
9 Push rod
10 Rocker arm, inlet valves
11 Rocker arm, outlet valves
12 Valve guide
13 Inlet valve
14 Exhaust valve
15 Exhaust channel
16 Turbo-charger, right
17 Engine oil heat exchanger
18 By-pass valve, heat exchanger
19 Starter
20 Pressure oil pump
21 Oil drain plug
22 Pre-heating element in engine oil tank
23 Crankshaft bearing cap
24 Crankpin
25 Generator
26 Connecting rod
27 Cylinder liner
28 Piston
29 Heater plug
30 Prechamber with burner
31 Nozzle holder with injection nozzle



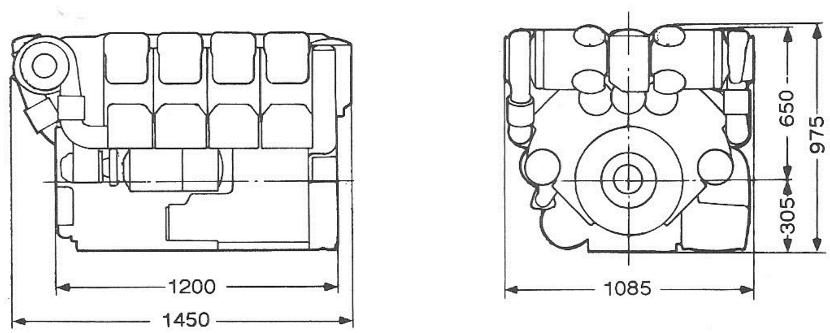
Longitudinal section of MB 838 Ca-M 500 engine

1 Filter for the engine housing vent
2 Leak-off fuel collecting line
3 Camshaft
4 Push rods
5 Coolant spaces in cylinder head
6 Nozzle holder with injection nozzle
7 Prechamber with burner
8 Inlet valves
9 Exhaust valves
10 Engine oil filter
11 Exhaust channel
12 Piston
13 Cylinder liner
14 Flywheel with starter ring gear
15 Crankshaft end bearing
16 Oil return pump, rear
17 Counterweight, crankshaft
18 Engine lubricating oil
19 Pressure oil pump
20 Oil return pump, front
21 Drive gear wheel for oil pumps
22 Vibration damper
23 Crankshaft gear wheel
24 Main oil channel
25 Transmitter for electrical speedometer, overspeed shift interlock and over-speed warning light
26 Connection of the lines for charger lubrication

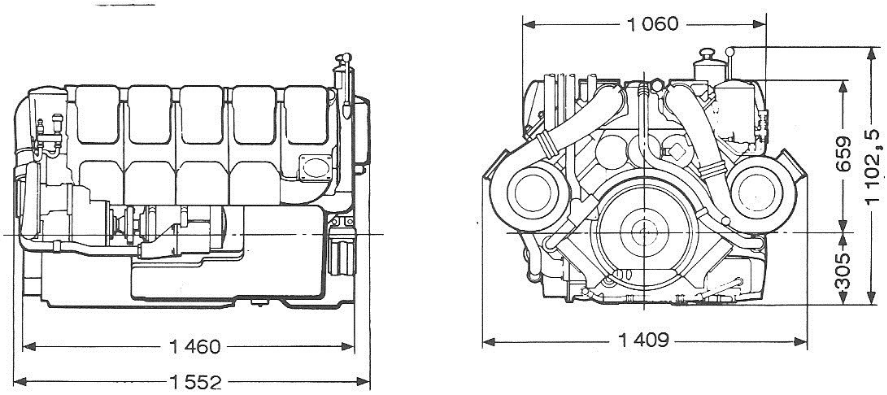




MB 833 Ea



MB 837 Ea

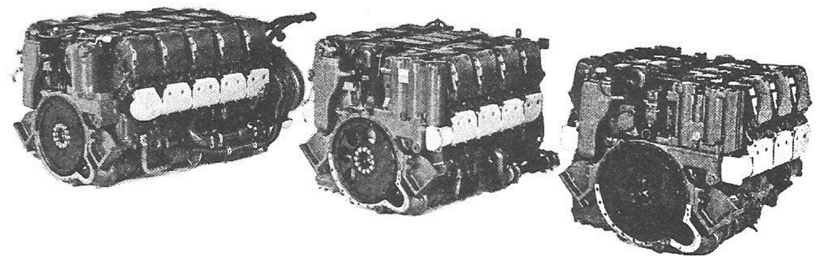


MB 838 Ca-M

mtu FRIEDRICHSHAFEN | Engine series MB 837

mtu FRIEDRICHSHAFEN

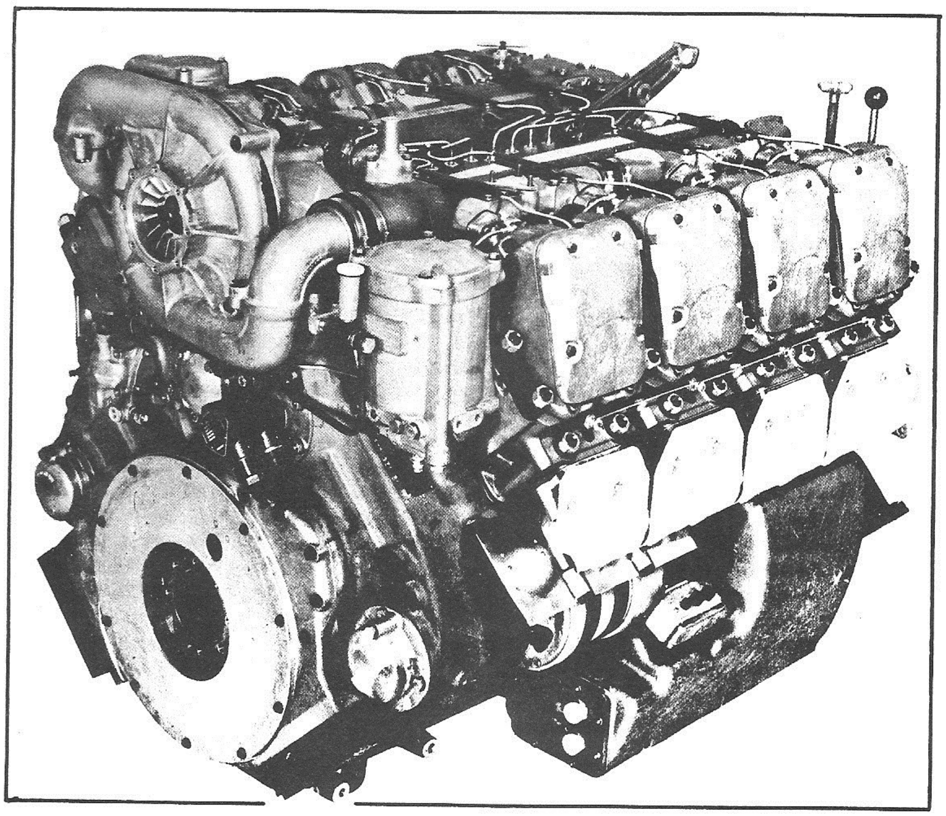
General technical data



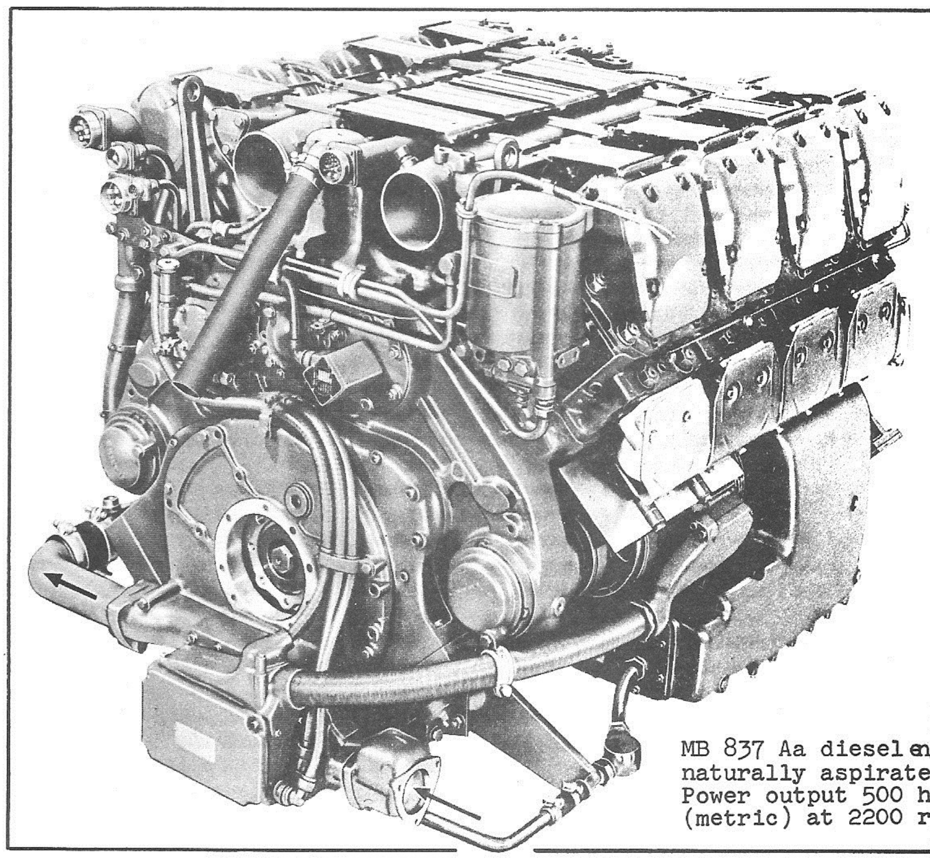
Engine type		MB 838	MB 837			MB 833
Model		CaM	Aa	Ba	Ea	Ea
No. of cylinders		10		8		6
Cylinder arrangement		90 ° V arrangement				
Cooling method		water				
Power output according to DIN 70 020	hp (metric)	830	500	660	730	600
Speed	rpm	2200	2200	2200	2100	2200
Maximum torque	mkp	286	177	225	265	206
at speed	rpm	1550	1400	1750	1700	1600
Bore/stroke	mm	165 / 175 6.5 6.9				
Swept volume of one cylinder	litres		3.74			
Total swept volume	litres	37.4		29.4		22.4
Dry engine weight w/o electrical equipment approx.	kg	1730	1375	1400	1540	1250
Actual engine bulk w/o cooling plant	m^3	1.6	1.28	1.3	1.4	1.26
Weight per horsepower	kg/hp	1.73	2.75	2.12	2.10	2.08
Actual bulk output w/o cooling plant	hp/m^3	615	390	510	520	475

MAIN BATTLE TANKS 61/68 (Switzerland)

MB 837 Ba diesel engine with one mechanical blower
Power output 630 hp (metric) at 2,200 rpm

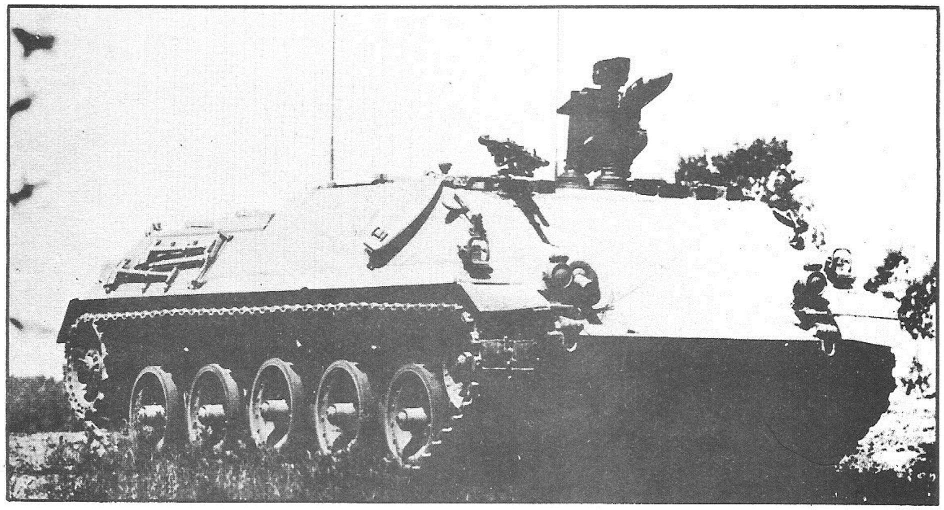


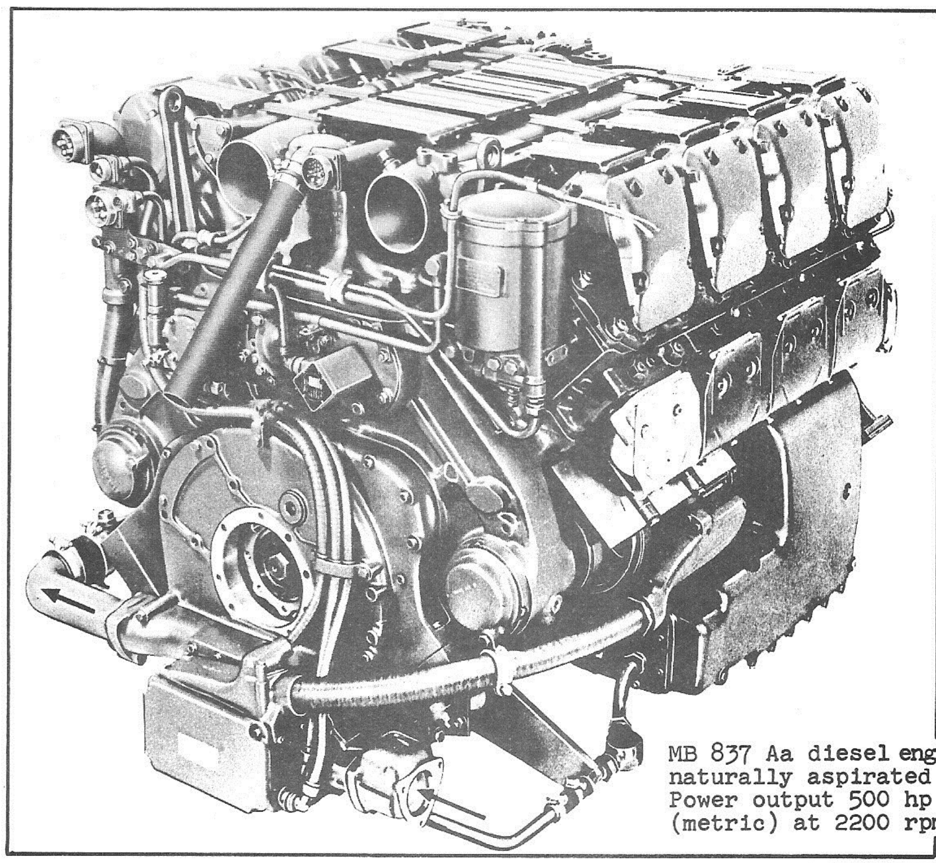
DESTROYER TANK "CANNON"



MB 837 Aa diesel engine
naturally aspirated
Power output 500 hp
(metric) at 2200 rpm

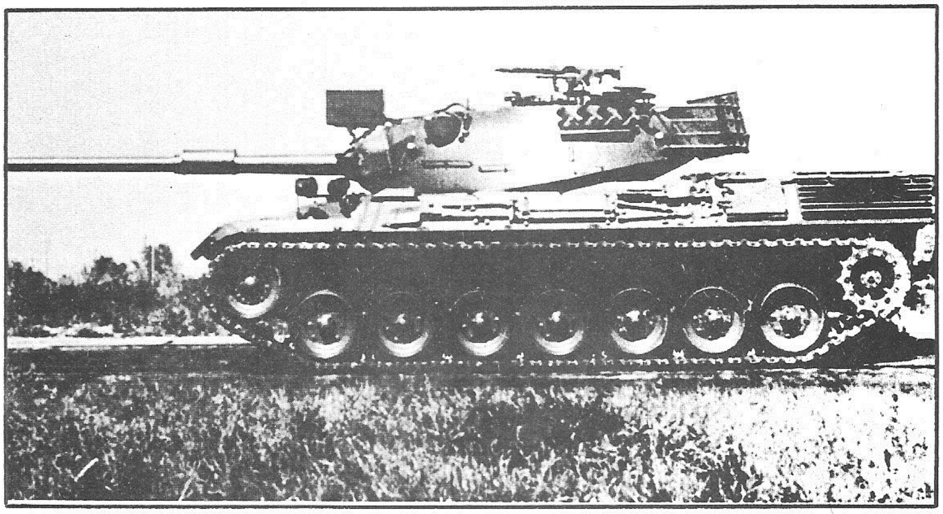
DESTROYER TANK "MISSILE"



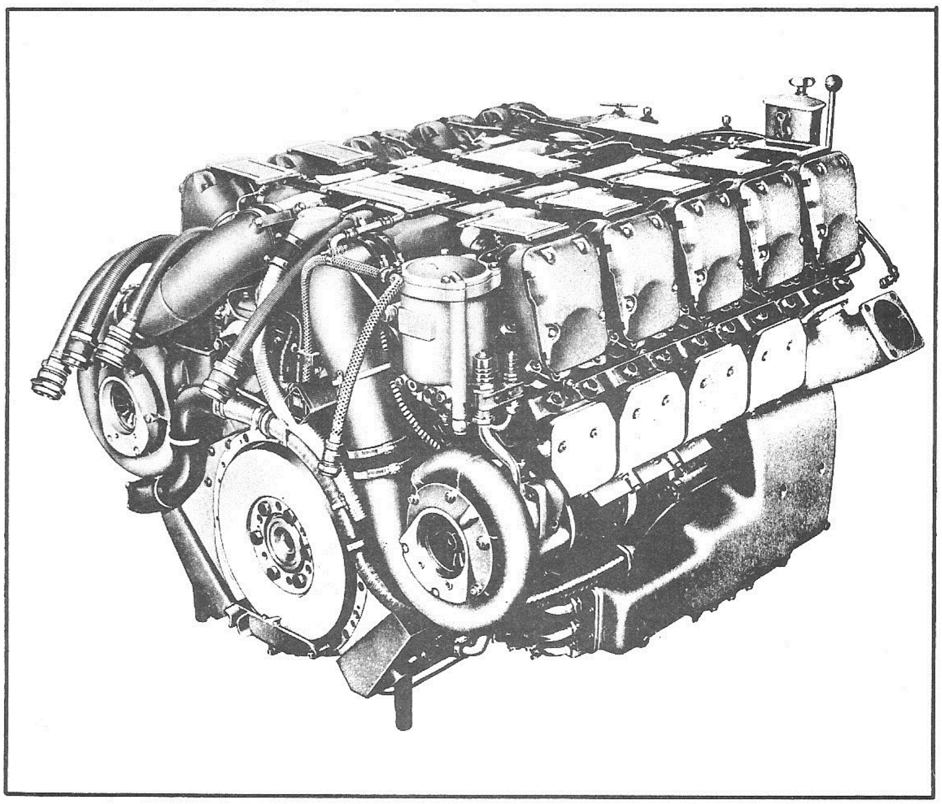


MB 837 Aa diesel engine
naturally aspirated
Power output 500 hp
(metric) at 2200 rpm

MAIN BATTLE TANK "LEOPARD I"



MB 838 Ca-M diesel engine with 2 mechanical blowers
Power output 830 hp (metric) at 2,200 rpm



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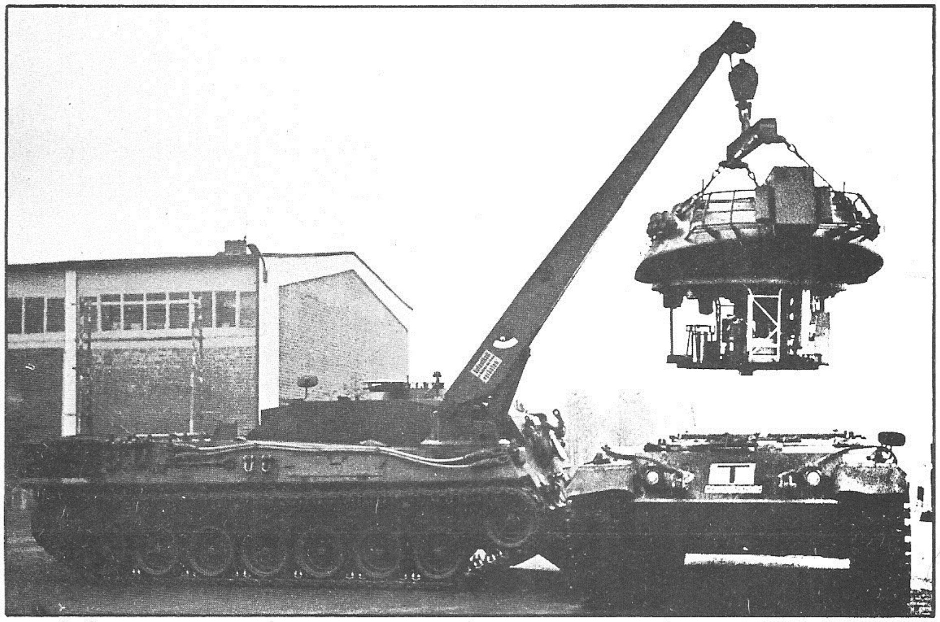
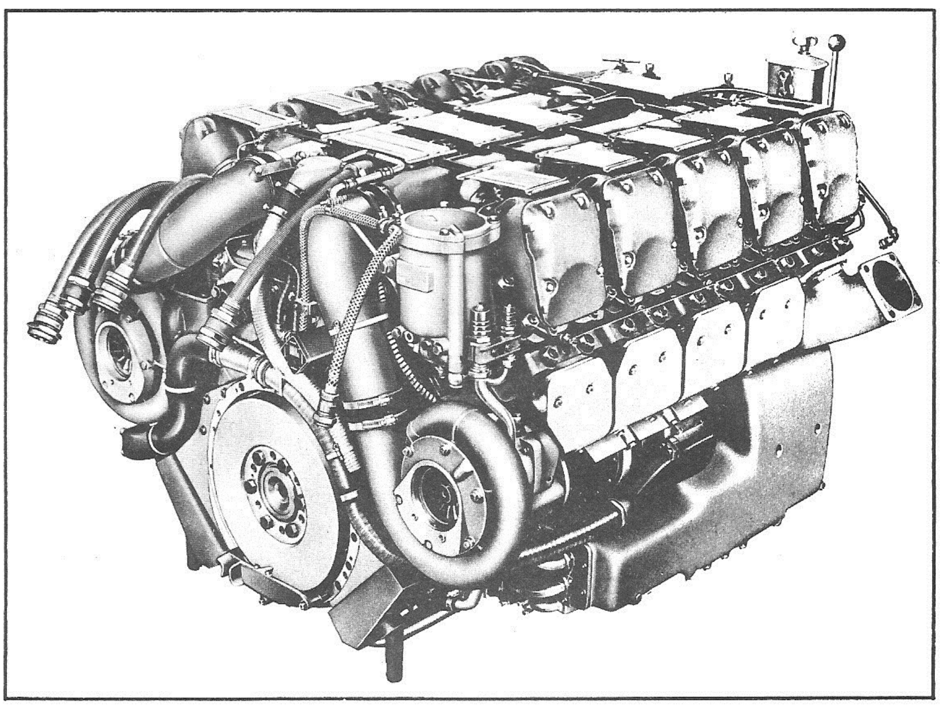
SALVAGE TANK WITHIN THE LEOPARD WEAPONS SYSTEM



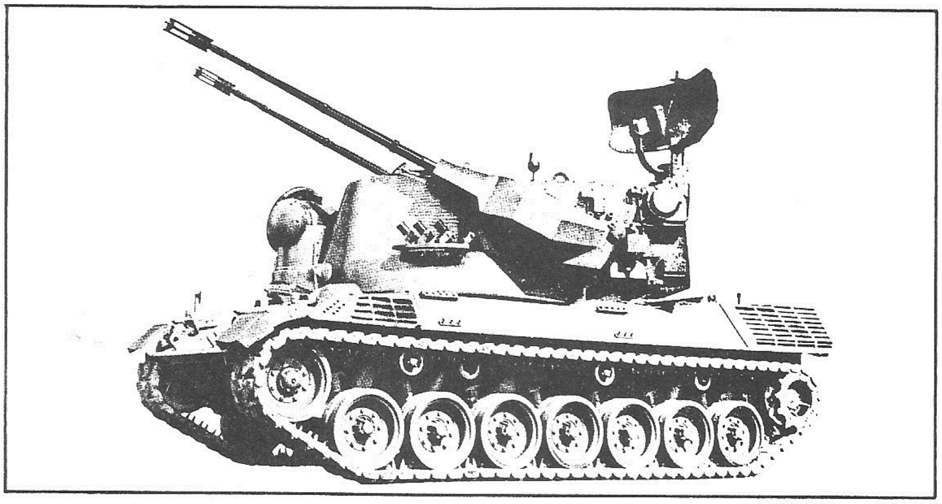
MB 838 Ca-M with 2 mechanical blowers
Power output 830 hp (metric) at 2,200 rpm



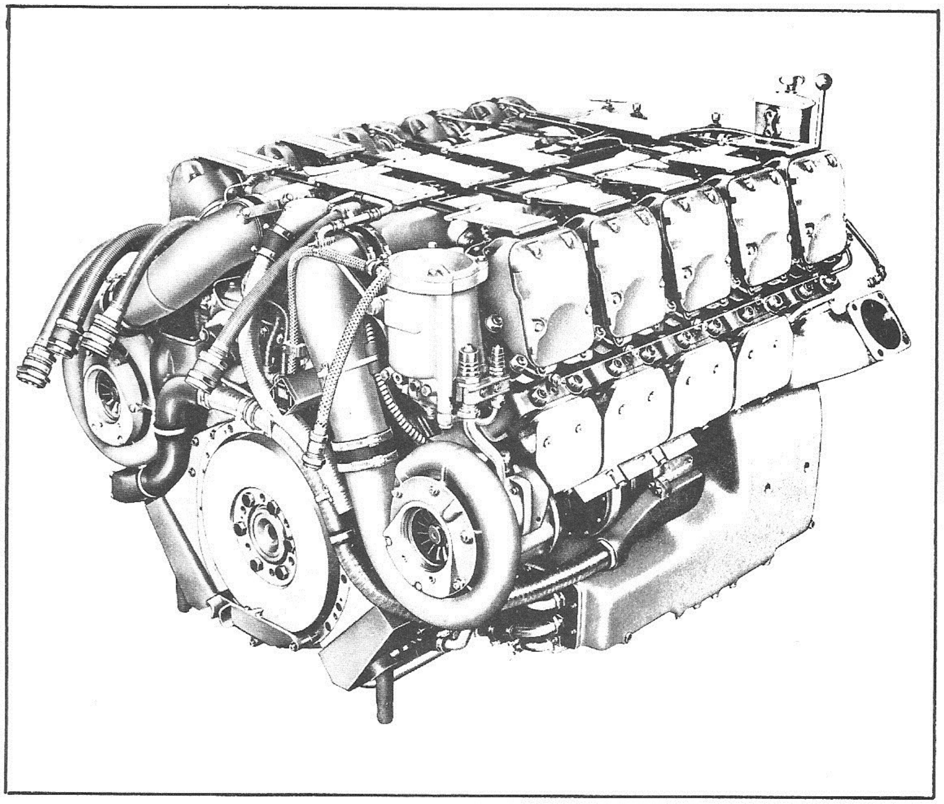
PIONEER TANK WITHIN THE LEOPARD WEAPONS SYSTEM

MB 838 Ca-M diesel engine with 2 mechanical blowers
Power output 830 hp (metric) at 2,200 rpm

A.A. TANK WITHIN THE LEOPARD WEAPONS SYSTEM

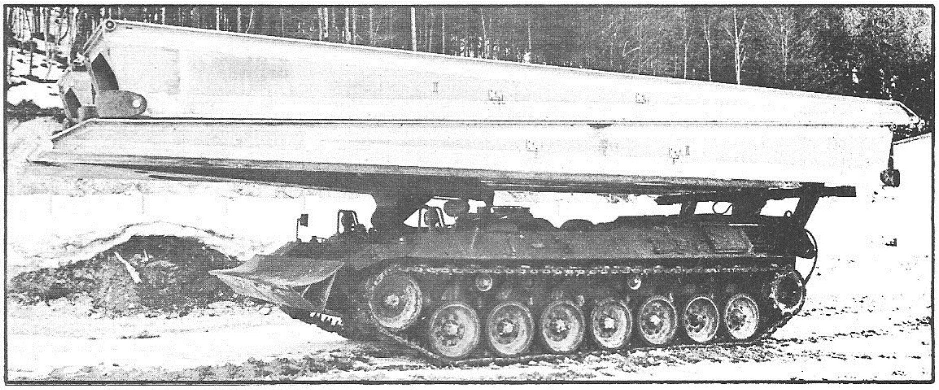


MB 838 Ca-M diesel engine with 2 mechanical blowers
Power output 830 hp (metric) at 2,200 rpm

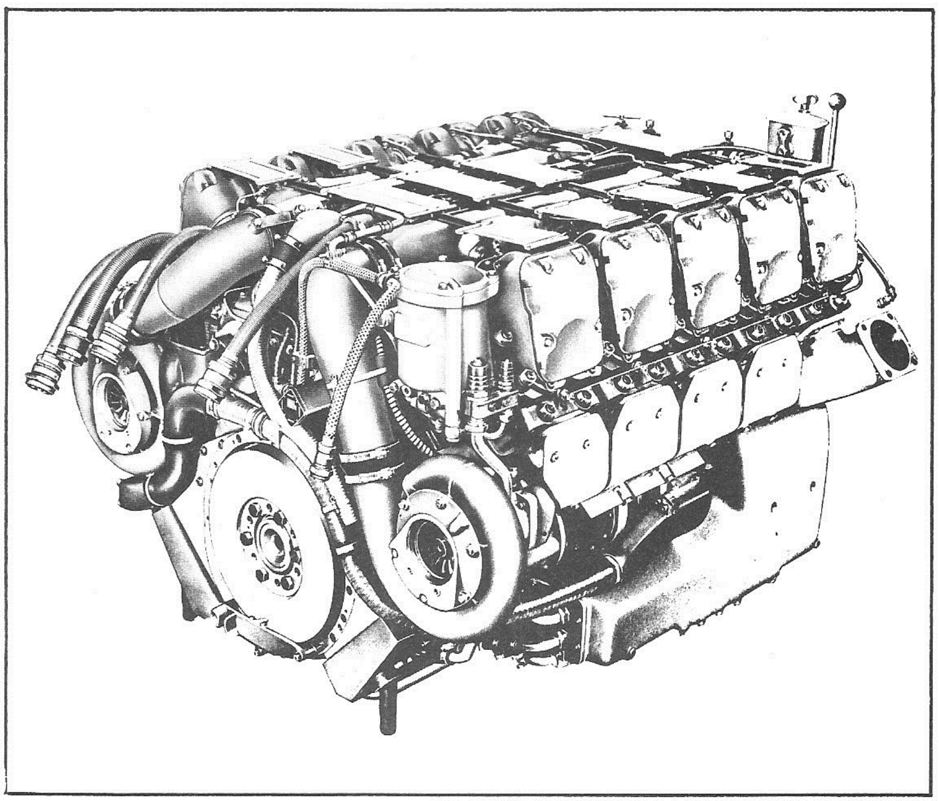


mtu FRIEDRICHSHAFEN

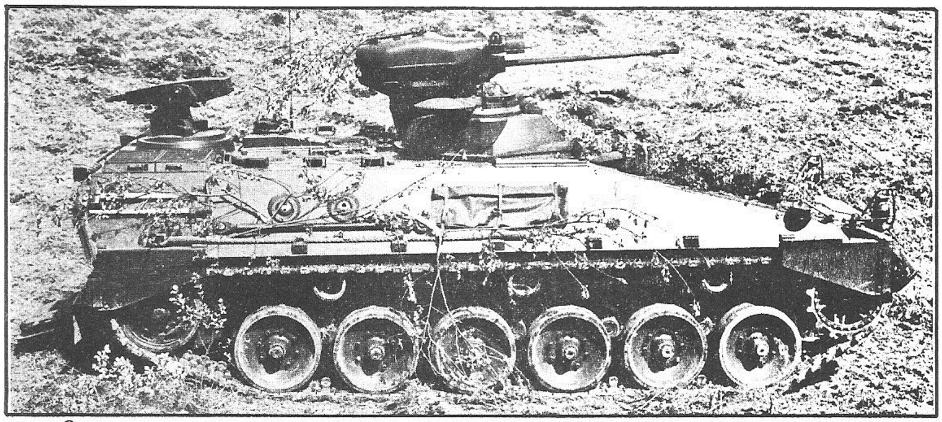
BRIDGE LAUNCHING TANK WITHIN THE LEOPARD WEAPONS SYSTEM



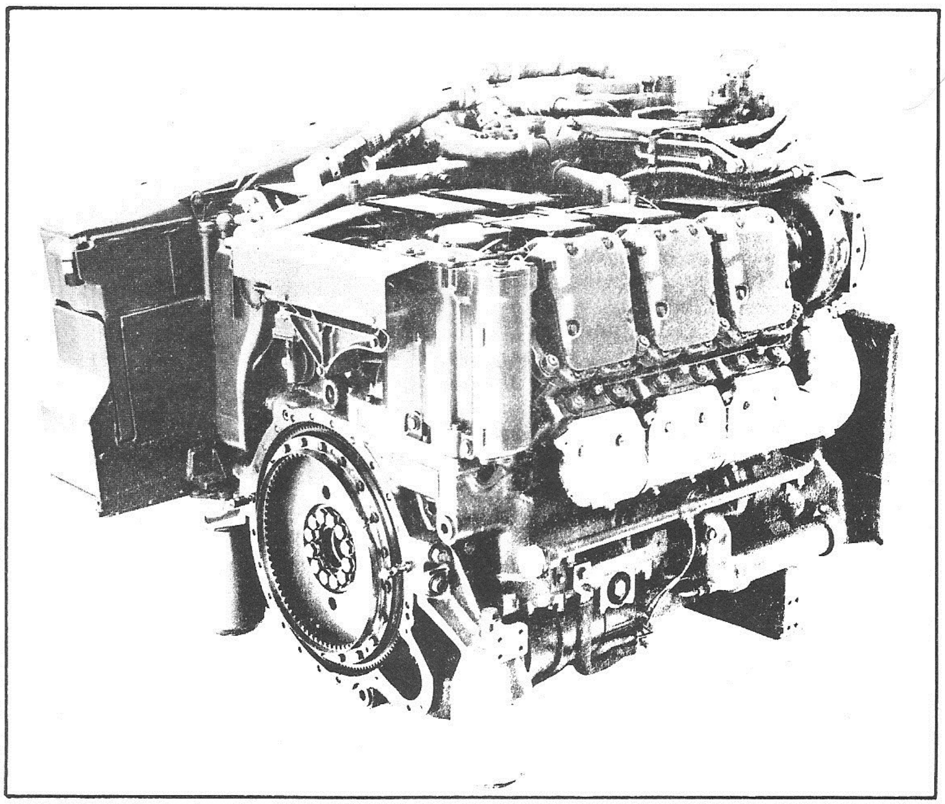
MB 838 CA-M diesel engine with 2 mechanical blowers
Power output 830 hp (metric) at 2,200 rpm



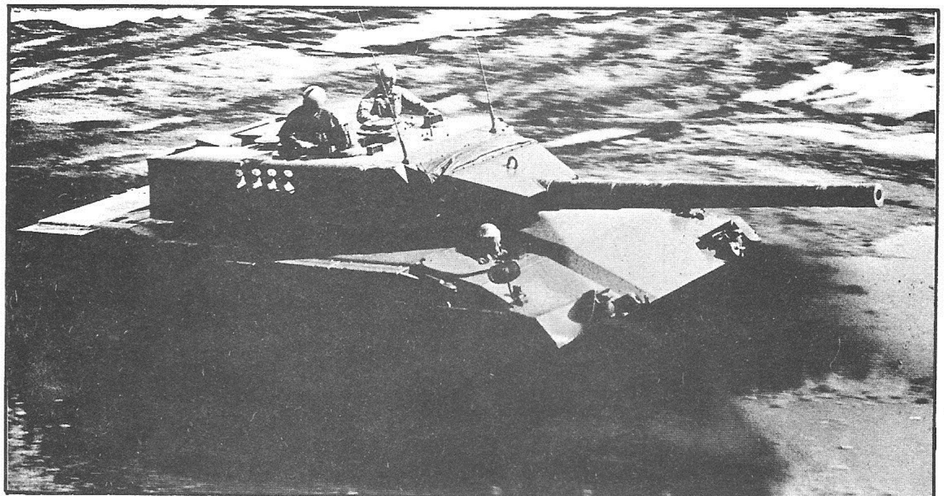
ARMOURED INFANTRY COMBAT VEHICLE "MARTEN"



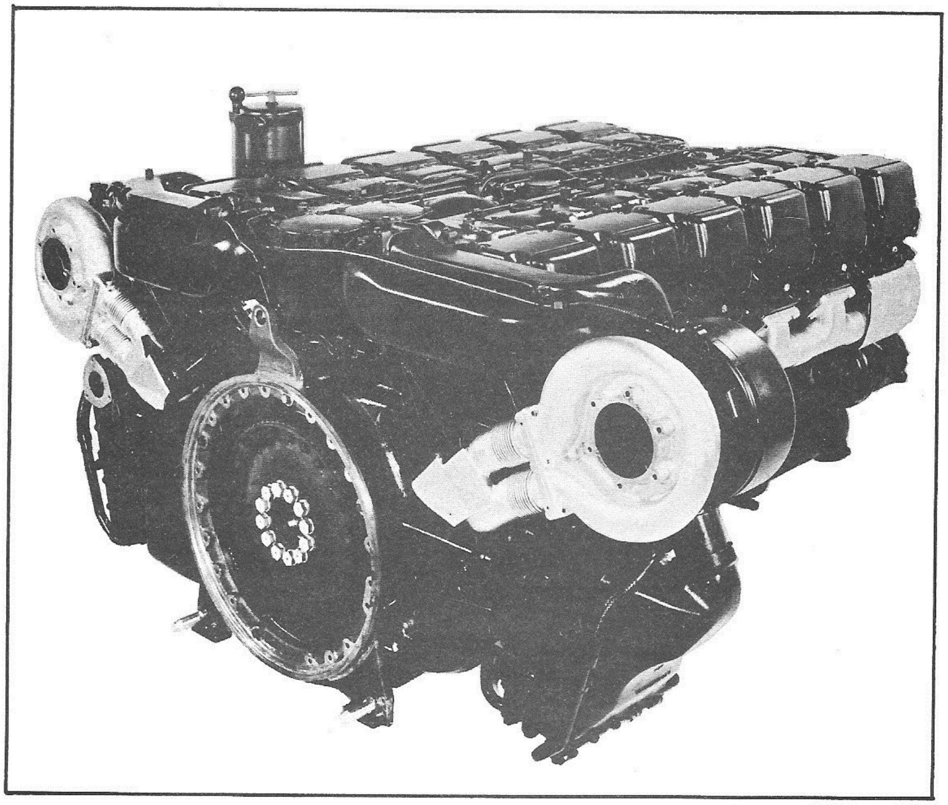
MB 833 Ea diesel engine with 2 exhaust gas turbochargers
Power output 600 hp (metric) at 2,200 rpm



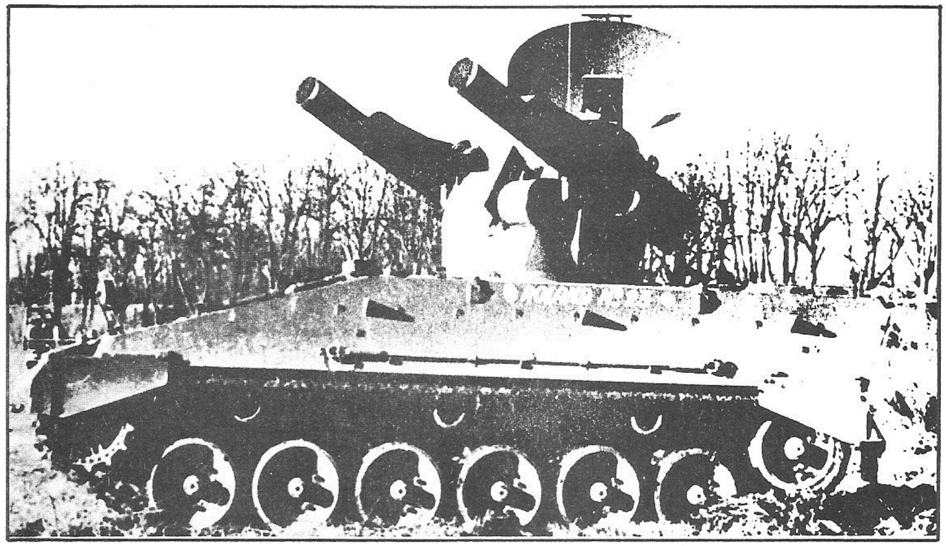
MBT "LEOPARD II K"

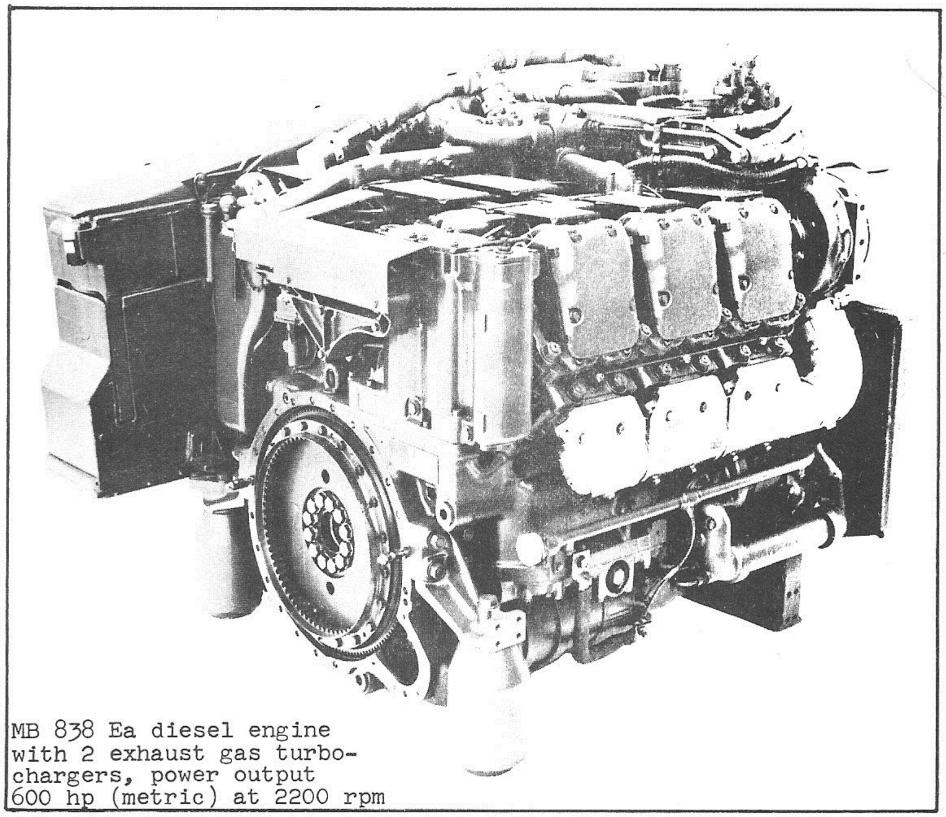


MB 873 Ka diesel engine with 2 exhaust gas turbochargers
Power output 1500 hp (metric) at 2600 rpm



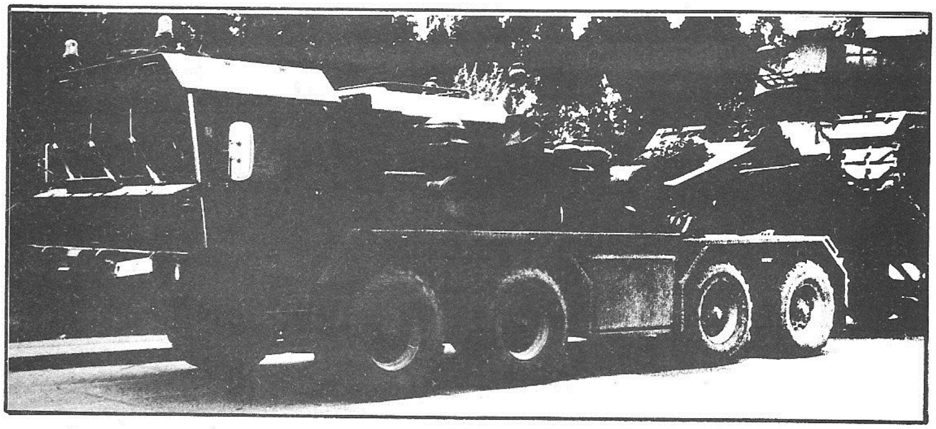
"ROLAND" WEAPONS SYSTEM



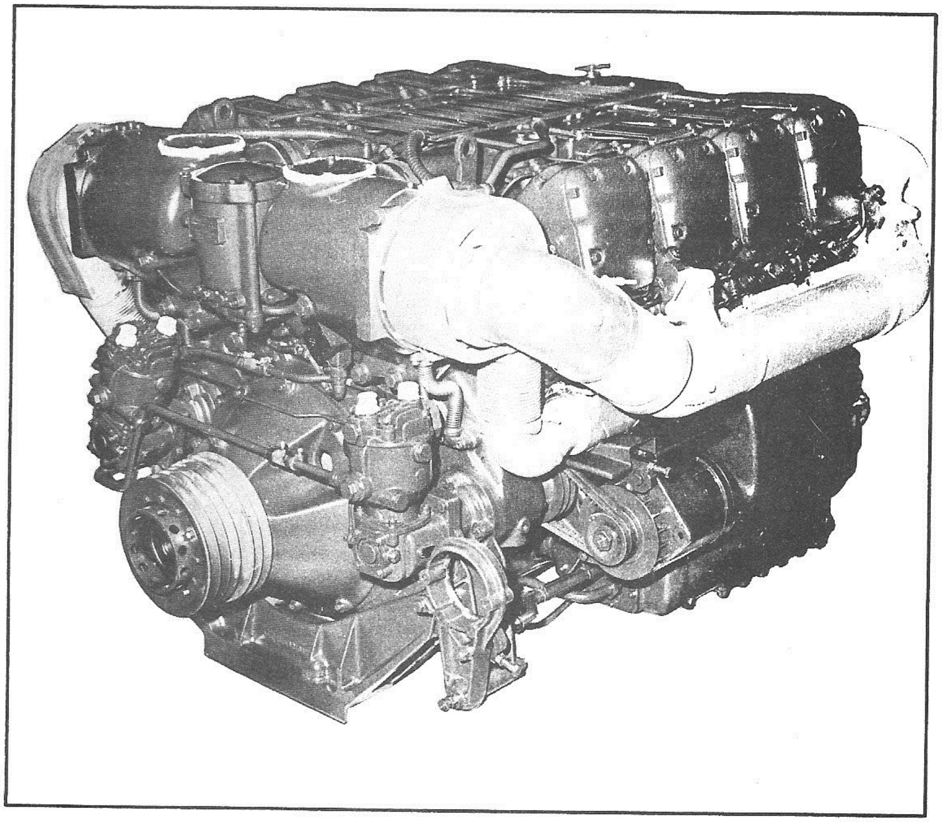


MB 838 Ea diesel engine
with 2 exhaust gas turbo-
chargers, power output
600 hp (metric) at 2200 rpm

FLATBED TANK TRANSPORTER SLT 50-2



MB 837 Ea diesel engine with 2 exhaust gas turbochargers
Power output 730 hp (metric) at 2,200 rpm



The MB 870 engine series

consists of liquid-cooled 6, 8, 10 and 12-cylinder four-stroke 90° V diesel engines operating according to the pre-chamber method. All of these units have an identical bore and stroke.

The engine housing is of light metal, its lower part being detachable. The replaceable wet cylinder liners are inserted into the housing from above. At the main power output opposite end the engine housing forms the gear train casing from where all ancillaries are driven through helical gear wheels.

The plain bearing supported crankshaft and connecting rods are completely machined steel forgings. Mass equilibrium is effected through counter-weights. The diagonal splitting of the connecting rods enables the pistons and connecting rods to be removed through the cylinders. The oil-cooled pistons are light metal forgings carrying three compression and two oil control rings.

The individual light alloy cylinder head castings have two inlet and two exhaust valves, which are concentrically arranged around the central pre-chamber. For a better heat conductance, the exhaust valves are filled with sodium. The valves are controlled by one camshaft for each cylinder bank, through roller tappets, push rods and rocker arms. They are closed by two coil springs each.

For an improved efficiency and an increased power output, the engines are provided with an exhaust gas turbo-charging system. The 8, 10 and 12-cylinder units have two turbochargers, while the 6-cylinder version uses only one. The pressurized air is re-cooled in charge air coolers which are included in the engine cooling water system, thereby attaining an optimum power output.

The engines are provided with a dry sump forced-feed circulation lubricating oil system. The oil in the lower part of the engine housing is drawn off by two oil return pumps delivering it to the oil tank fitted to the engine. A pressure oil pump draws the oil from the tank and forces it to the different lubricating points, through the engine oil heat exchanger and filters.

By means of a motor-driven pump as fitted to the vehicle the fuel is transferred to the injection pump, through the fuel cooler and the respective filtration system. The injection pump with flange-mounted governor is arranged in the engine saddle, and driven by the fuel injection timer. Lubrication of the pump is effected through the engine lubricating oil system.

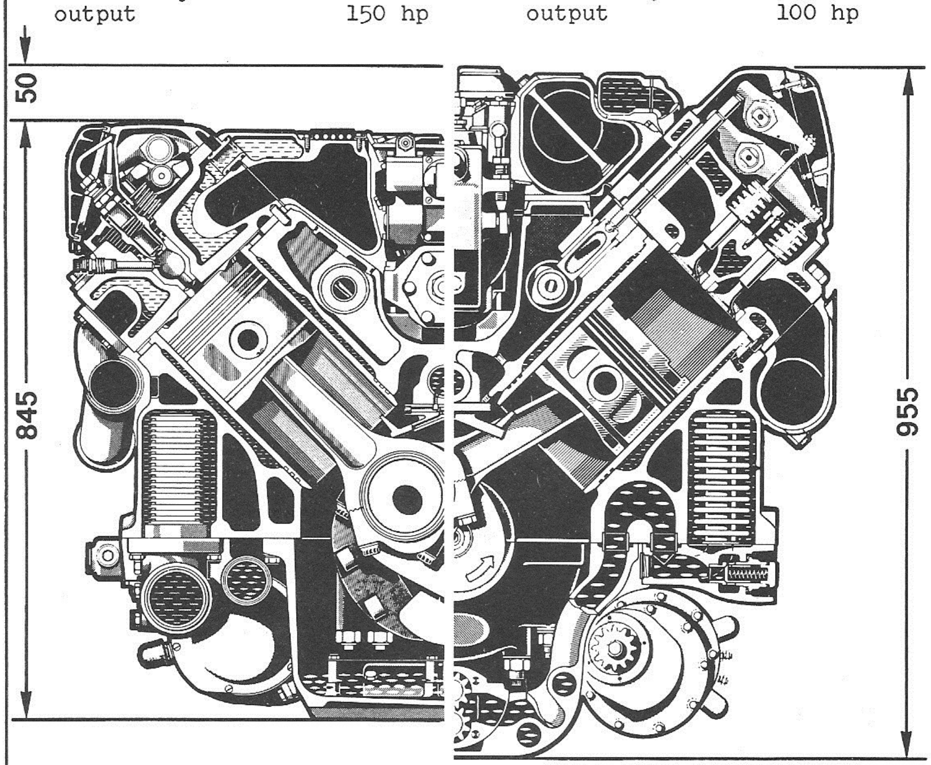
For the engine cooling they use a pressurized system. Two thermostats ensure a constant operating temperature. The circulating pump as driven by the gear train forces the coolant through the oil heat exchanger, charge air cooler, engine cooling spaces and gearbox oil cooler to the air-to-water cooling system dealing with the central re-cooling.

Arrangements have been made for the MB 870 engine series to include the following types:

MB 870 Ka	6-cylinder V engine with exhaust gas turbocharging and internal charge air cooling
MB 871 Ka	8-cylinder V engine with exhaust gas turbocharging and internal charge air cooling
MB 872 Ka	10-cylinder V engine with exhaust gas turbocharging and internal charge air cooling
MB 873 Ka	12-cylinder V engine with exhaust gas turbocharging and internal charge air cooling

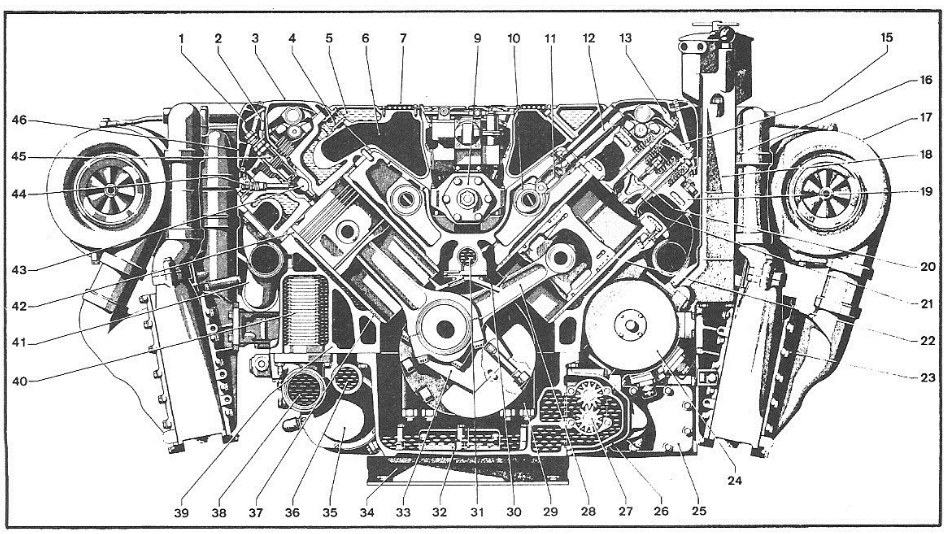
Cross sectional comparison of MTU high performance diesel engines MB 837 and MB 873

MB 873		MB 837	
Swept volume of one cylinder	3.31 litres	Swept volume of one cylinder	3.74 litres
Maximum cylinder output	150 hp	Maximum cylinder output	100 hp



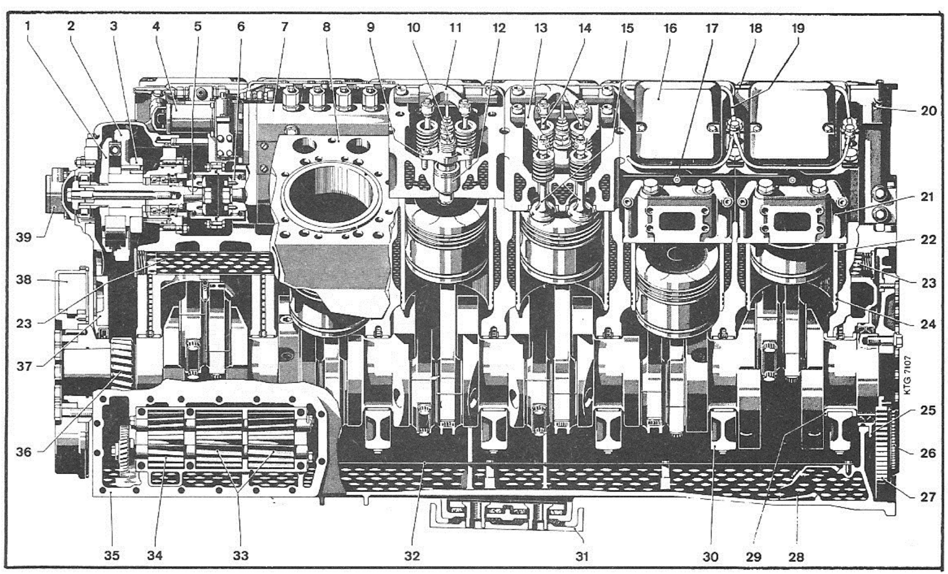
Cross section of MB 873 Ka engine

1 Fuel injection pipe
2 Leak-off fuel line
3 Gear train housing
4 Coolant transfer ferrule
5 Coolant manifold
6 Charge air manifold
7 Fuel injection pipes
9 Fuel injection pump
10 Camshaft
11 Roller tappet
12 Push rod
13 Rocker arms for inlet valves
14 Engine housing vent
15 Rocker arms for exhaust valves
16 Charge air manifold
17 Exhaust gas turbo-charger
18 Oil filler
19 Cylinder head
20 Inlet valve
21 Exhaust valve
22 Piston
23 Charge air cooler
24 Generator
25 Preheater in engine oil tank
26 Oil pump housing
27 Pressure oil pump
28 Connecting rod
29 Crankshaft bearing cap
30 Oil injection nozzles
31 Oil gallery
32 Lower part of engine housing
33 Crankshaft
34 Engine mounting
35 Starter
36 Oil inlet, heat exchanger
37 Cylinder liner sealing
38 Coolant inlet, oil heat exchanger
39 Upper part of engine housing
40 Oil heat exchanger element
41 Exhaust gas manifold
42 Cylinder liner
43 Pre-chamber
44 Heater plug
45 Injection nozzle holder
46 Cylinder head bonnet

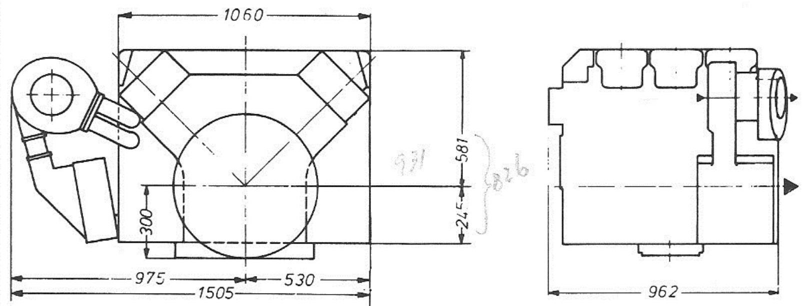


Longitudinal section of MB 873 Ka

1 Fuel injection timer
2 Injection pump drive wheel
3 Camshaft idler gear wheel
4 Shutdown solenoid
5 Injection pump drive shaft
6 Injection pump drive coupling
7 Injection pump
8 Cylinder head supporting area
9 Clamp for securing injection nozzle and pre-chamber
10 Injection nozzle holder
11 Rocker arms for inlet valves
12 Pre-chamber
13 Rocker arms for exhaust valves
14 Inlet valves
15 Exhaust valves
16 Cylinder head bonnet
17 Heater plug
18 Injection line
19 Leak-off fuel line
20 Engine oil filter
21 Cylinder Head
22 Cylinder liner
23 Oil gallery
24 Lower sealing of cylinder liner
25 Crankshaft sealing
26 Follower flange for converter
27 Starter ring gear
28 Rear suction end for oil return pump
29 Crankshaft end bearing
30 Crankshaft bearing cap
31 Engine mounting
32 Oil baffle plate
33 Oil return pumps
34 Pressure oil pump
35 Engine housing, lower part
36 Crankshaft gear wheel
37 Engine housing, upper part
38 Vibration damper
39 Speed transmitter



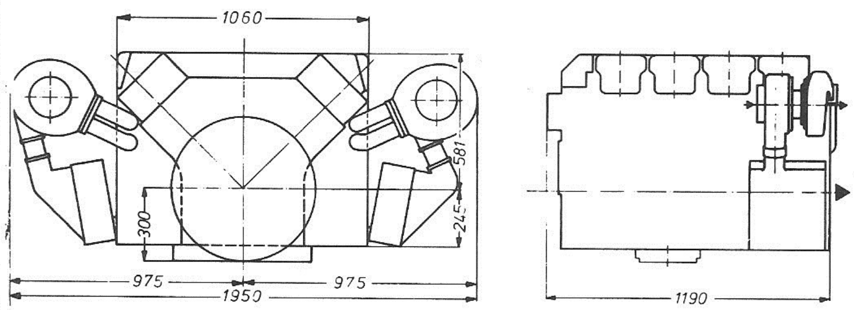
863 cummins



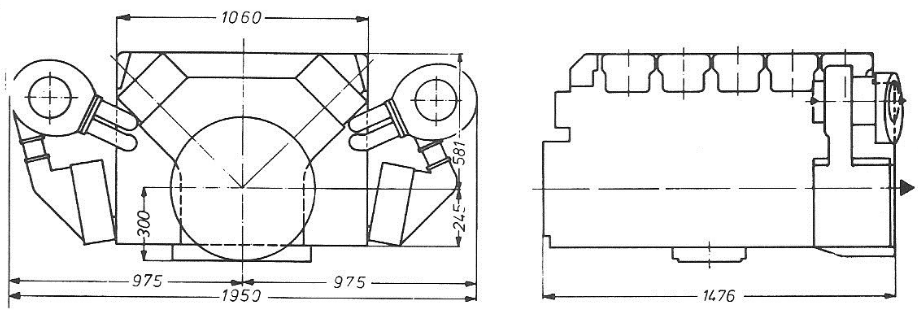
600/700 Cummins 870 x 10^6
900HP MTU 686 x 10^6
750HP I-F 769 x 10^6

1084 Cummins V903

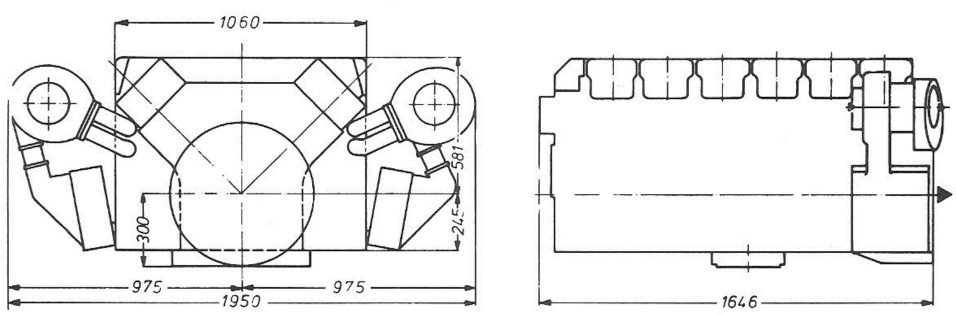
MB 870 Ka



MB 871 Ka



MB 872 Ka

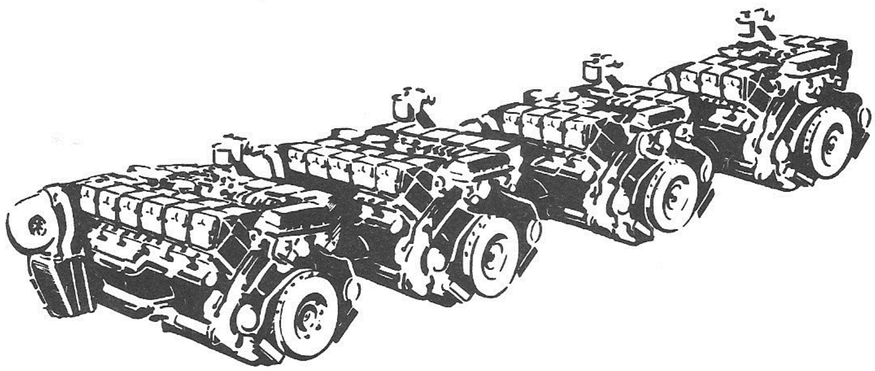


MB 873 Ka

mtu FRIEDRICHSHAFEN

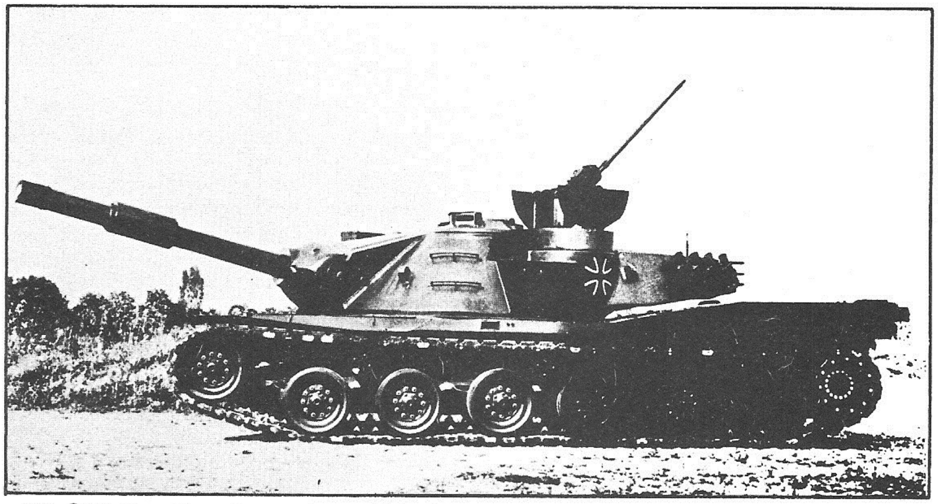
Engine series MB 870

General technical data

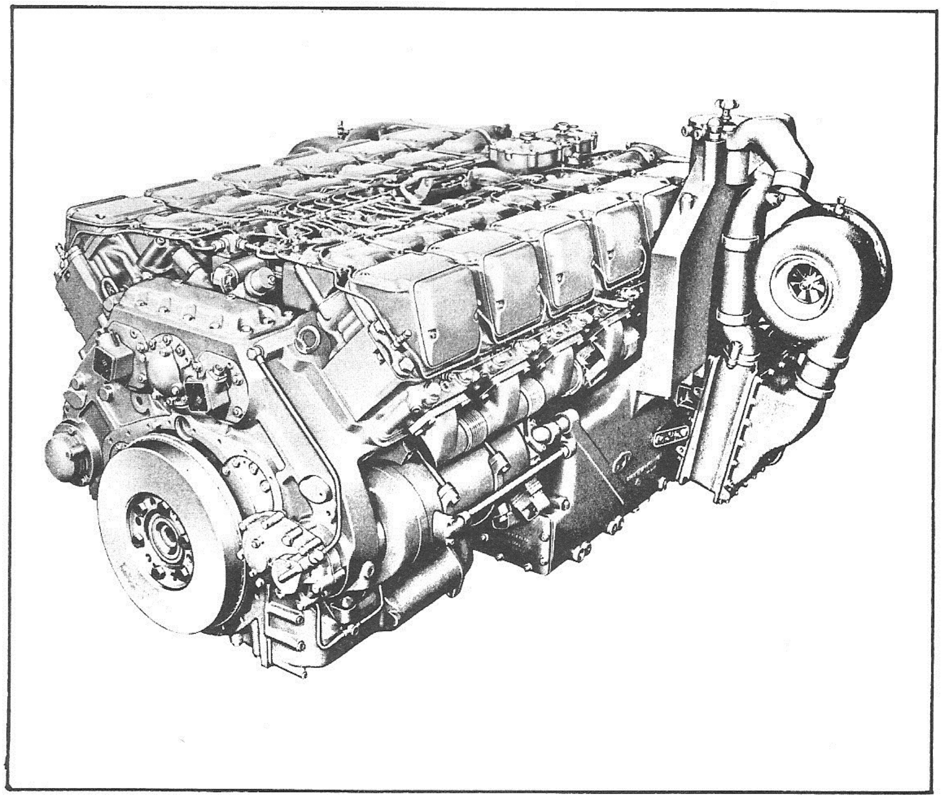


Engine type	MB 873	MB 872	MB 871	MB 870
No. of cylinders	12	10	8	6
Cylinder arrangement		90 °V arrangement		
Cooling method		water		
Power output according to DIN 70 020 hp (metric)	1800	1500	1200	900
Speed rpm	2600	2600	2600	2600
Maximum torque at 2000 rpm mkp	535	444	360	268
Bore/stroke mm		165/155		
Swept volume of one cylinder litres		3.31		
Total swept volume litres	39.6	33.0	26.4	19.8
Dry engine weight w/o electrical equipment approx. kg	1940	1800	1490	1240
Actual engine bulk w/o cooling plant m^3	1.65	1.45	1.25	1.05
Weight per horsepower kg/hp	1.08	1.20	1.24	1.38
Actual bulk output w/o cooling plant hp/m^3	1090	1035	960	860

MBT 70 (Project Study)



MB 873 Ka diesel engine with 2 exhaust gas turbochargers
Power output 1500 hp (metric) at 2600 rpm



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